CHEMICAL & METALLURGICAL ENGINEERING

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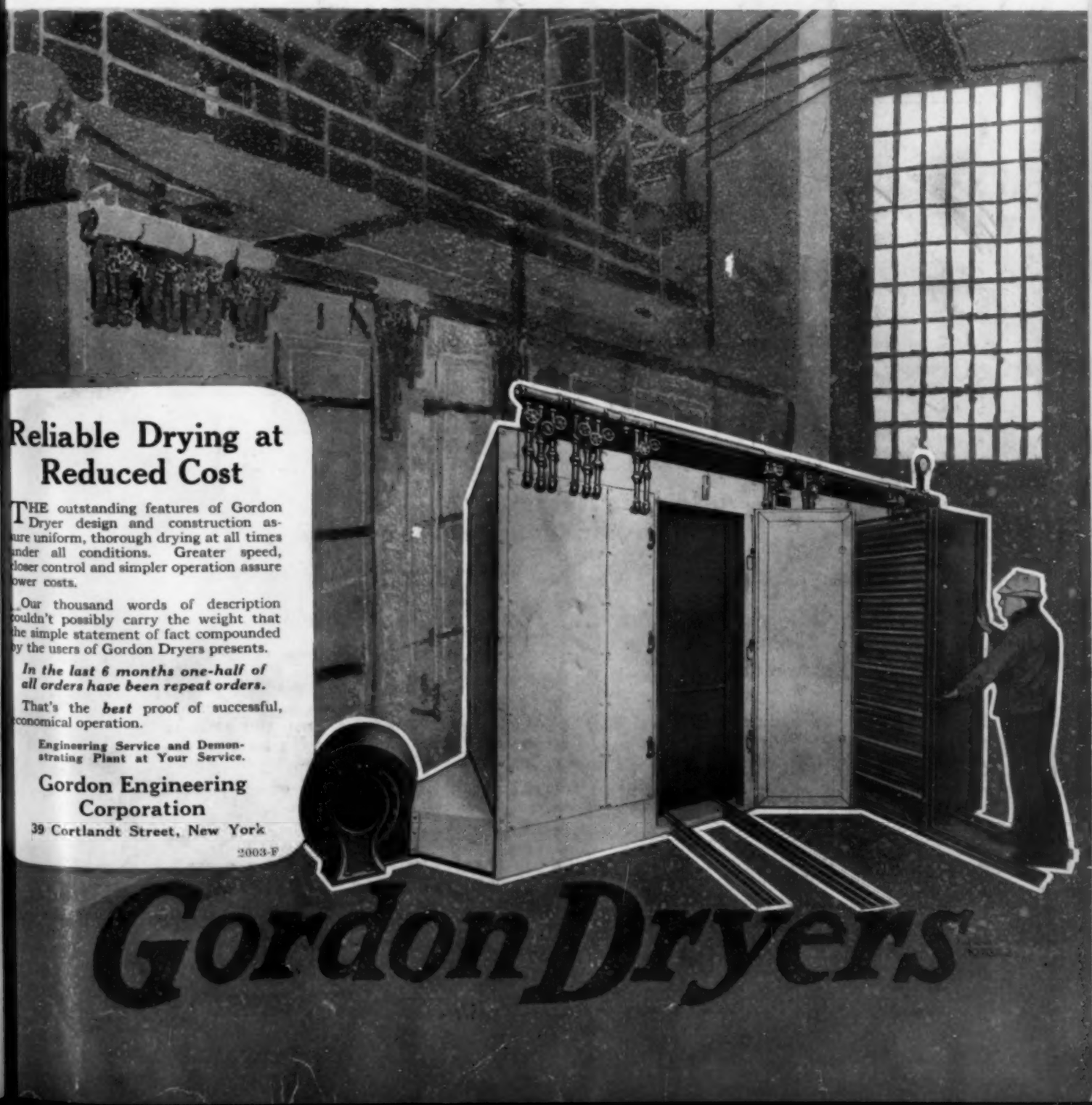

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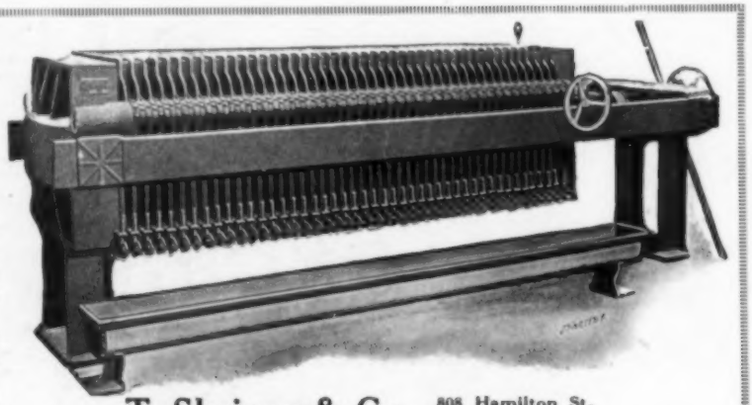

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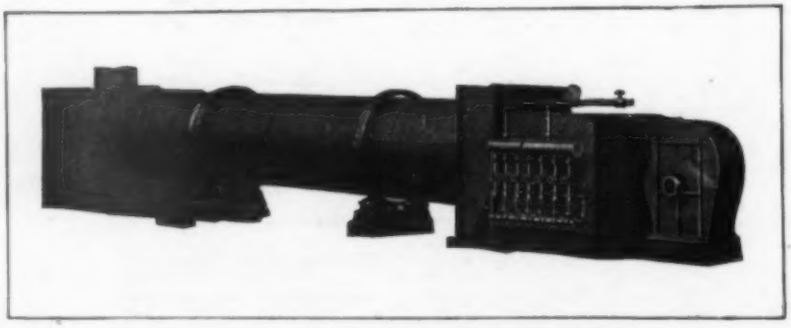

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Match Your Patriotism Against the National Army Men

A PROGRESSIVE and trustworthy employer of a large amount of labor in a middle western metallurgical industry states that while the average wage had increased 48 per cent over that paid immediately preceding the war, the cost of getting the same work done had risen 67 per cent owing to an actual decrease in efficiency of the higher-paid labor. This is startling enough, but far more impressive when contrasted with the spirit existing for instance in our flying schools, where as one cadet put it, "If anyone had asked me to work half as hard in civil life for double the pay I would have laughed at him."

Un-Americanism infiltrates throughout industry; pure Americanism is rampant among our flyers. Industry is packed with immigrants foregathering in unlovely settlements, stewing in ignorance and squalor, this mass being more or less feebly leavened with native unionists bred with limitation-of-output ideas and superintended too often by "slave drivers" pure and simple. On the other hand, our flyers are gathered from our colleges, universities and technical schools, those institutions at once the child and mother of liberty, and are officered by self-sacrificing patriots and scholars. One's pride in our soldiers matches illy his apologetic toleration of wage- and business-profiteers.

As recent events show, we Americans need a rude jolt to waken us—a tinkling alarm cannot penetrate our complacent superficiality, our inability to pursue an idea to its ultimate conclusion. For instance, in response to early warnings of impending fuel famine, New York City darkened Broadway! Officialdom also seems to bow to the great American ego when it exempts taxi-drivers from the "Work or Fight" order. We adopted the selective draft because we knew that volunteering in mass would not follow war's declaration. We are too heterogeneous to act with unanimity: scant majorities rule. Yet we could not bring ourselves to the equally obvious draft of the production indispensable to maintain our growing army. Too many manufacturers refuse munition orders at 15 per cent profit when peace orders net many times more. Priorities may force a change of heart: lack of coal, lack of steel, lack of transportation, will doubtless temper "business patriotism."

But how can we bring workers into shipyards, munition works, food production? How impress them with the idea, as William Hard puts it, that it is just as wrong to abandon a gun-carriage which is being made to kill Germans as to abandon a gun-carriage which is killing Germans? Conscription of labor—the corollary of conscription of fighters and the conscription of industries—naturally is not popular with the workers,

even though it is virtually in effect under the provisions of the selective draft which allows industrial exemption. Yet any class should realize that a draft is surely coming unless the impossible ensues, unless they volunteer *en masse*. As far as the native worker is concerned, the impossible might be possible, if he were sure that the sacrifice of his present status would not redound to the employers' immeasurable profit.

Here a campaign of education would help; indeed where would it not help? For instance, the employers might well recognize the fact that they may tardily institute Americanization classes among the immigrants they are largely responsible for, seriously endeavor to improve working, housing and cultural surroundings of their workers, and seek by every means possible an *entente cordiale* between all parts of their organization.

Employer and employee alike must give and not grasp. Give until it hurts, even to surrendering conflicting "rights." Match patriotism and sacrifice with the sacrifice of the national army men, and you, as they, will be new born, will gain more than lose, and emerge better and cleaner citizens of America.

Germany's Finger in the Platinum Pie

FIRST let us dig up a little history. Thirty years ago the world's headquarters for platinum were with Johnson, Matthey & Co., Ltd., of London. Then, following the path of trade in many other branches of industry, the Germans took a hand and there arose one Heraeus, who became a man of might. The American manufacturing business was promising but undeveloped, although it started here. There was the Bishop concern in Pennsylvania and Baker & Co. of Newark, both small, the latter also refining gold and silver from jewelers' sweepings, photographers' residues, etc. In the meantime an understanding appears to have been reached between Heraeus in Germany and Johnson, Matthey & Co. in England.

Next we observe the organization of the American Platinum Co. of Newark, and find Mr. Charles Engelhardt in control, seconded in time by his able assistant, Dr. Zimmermann, a reserve officer of the German army. Mr. Engelhardt also came from Germany, but whether he was sent here as an agent of Heraeus or came independently we do not know. Soon the Baker establishment began to expand, far beyond the means and credit presumably available to the firm as it was, and they proceeded to make platinum stills for sulphuric acid and other apparatus on a large scale. We do not affirm that these extensions were paid for by German capital, we merely state our understanding that a large percentage of the stock was soon owned by Heraeus and Engelhardt on the one hand and an equal share by Johnson, Matthey & Co. on the other. Heraeus also is said to have owned a one-fifth interest in Johnson, Matthey & Co.

Shortly after the enlargement of the Baker concern and the accession of new interests, the price of platinum advanced out of all proportion; far higher than trade conditions warranted. The situation displayed all the stigmata of the presence of a regular, old-fashioned, millions-in-it trust. The senior Baker died and so did one of his sons, leaving Cyrus O. and Charles in the business. Now Cyrus also is dead, and while Charles still participates in it, the platinum headquarters in America are to be found under Mr. Charles Engelhardt's hat and not elsewhere. In the meantime Baker & Co., Inc., are reported to have gone into the manufacture of platinum jewelry mountings on a large scale.

The complexities of German ownership grew apace. There was the Croselmire concern which was originally a gold and silver refinery similar to the original Baker house, and a competitor. This was taken over by Roessler & Hasslacher who proceeded to offer platinum and platinum compounds for sale. Roessler & Hasslacher are or were connected with and established by the Deutsche Gold & Silber Scheideanstalt at Frankfort on the Main. What the relations between the Scheideanstalt and Heraeus are we do not know, but the disposition of German houses is to be friendly in foreign trade. Neither can we give the relations between the corporations named and other refiners of the metal in this country except to note that the trade seems to be closely organized.

Whatever the original composition of the international platinum syndicate, it is evident that Johnson, Matthey & Co. dropped out when the war began and they have had to shift for themselves. We are informed that Mr. Engelhardt and his friends have taken over the Heraeus interests in the American organizations. He is, we understand, an American citizen, and he has functioned as the advisor in regard to the metal with which he is abundantly familiar, to the Division of Chemistry of the War Industries Board. The chairman of this department is Mr. L. L. Summers. And here we reach a situation that we would like very much to have explained.

Mr. F. W. Draper brought over from Russia for sale 20,000 ounces of platinum which was the property of the Russian and English Bank. He was authorized to sell it for $105 an ounce. On the arrival of the metal in New York it was commandeered by the War Industries Board. There followed a series of interviews between Messrs. Summers and Draper, in which Mr. Summers offered to pay $90 an ounce for it and no more and refused to let it be sold elsewhere. Mr. Draper protested and so did the Bank, claiming that this would involve the institution in serious financial loss, but $90 an ounce is all they received. Mr. Draper said that the bank had 15,000 ounces more for sale and that at the time they were able to produce and deliver still more, but it is also said that after the $90 episode they gave up the idea of sending any more platinum to the United States. Now if the German interests wanted to prevent the metal from reaching this country so as to make us slow down on the production of the needed oleum for munitions they could not have asked for a more effective means to accomplish their purpose.

The present situation is that we need more platinum than there is in sight. That is a fact and we are not interested in the opinions of laymen as to what substitutes are available for various purposes or what the effect of such steps as may be necessary will be upon the 1918 profits of the jewelry trade. What we would like to know is whether Mr. Summers cut the price for Mr. Draper from $105 to $90 on the advice of Mr. Engelhardt or on his own initiative. If it was wholly on his own initiative it was a blunder—but we all make mistakes. On the other hand, if it was at the

suggestion or on the advice of Mr. Engelhardt, who is too well posted on platinum affairs to make serious errors in calculation, it will establish in us the fear that he is still a little too close to the Heraeus outfit to be an entirely safe advisor in time of war.

There has been too much talk and too little doing in this matter. It is amazing to consider that serious men will listen to the effort to balance up fashions and styles in jewelry with the country's need in its hour of peril. There is just one way out of this difficulty and that is for the U. S. Government to take control and possession of every plant that handles platinum and proceed to order sales according to requirements.

The Committee on Ways and Means spent the better part of three days listering to the views of jewelers, chemists and Government representatives on the platinum situation. While the committee was not enlightened on the question of how to raise revenue from platinum, it did receive considerable information which Congress as a whole might read to its profit. By far the best advice the committee received was that there should be no platinum to tax; that the Government should gather into its vaults all platinum not now serving a useful purpose in war work and hold it against the time when it may be needed.

Increasing Production of By-Product Coke

UNDER pressure of war demand for explosives, first by the Allies and then by the United States Government, there is no end to the building of by-product coke ovens. An astonishing showing is being made for these days of high construction costs. The more important items of by-product oven completion are 140 ovens put in operation at Gary early in the year; 180 ovens at Cleveland (American Steel & Wire Company), which made their first coke in May and are now in full operation; 128 ovens at Clairton (Carnegie Steel Company), which made their first coke late in June and are now in full operation, with four similar batteries of 128 ovens each to be completed at various times to December 31; 208 ovens at Lorain, O. (National Tube Company), half of which are now in operation, with the other half to be completed in 30 to 60 days; and 102 ovens at Youngston (Youngston Sheet & Tube Company), half completed and half to be completed in 30 to 60 days. Smaller completions are 65 ovens of the Minnesota By-Products Company, 24 of the Chattanooga Coke & Gas Company and 60 of the Bethlehem Steel Company at Steelton, Pa. The ovens completed this year to date represent about 3,000,000 net tons a year in actual coke production and the ovens still to be completed this year approximately as much, perhaps somewhat more, possibly somewhat less. In addition there are many projects that have been on the way for some time, together with a fresh batch inaugurated within the past three months, in some of which Government financing is involved, the builders to take the ovens from the Government after the war at an appraised valuation.

For an industry growing so rapidly the annual production reports of the Geological Survey are only of general value, for the reported production of a year does not indicate the capacity at either the beginning or end of the year or even the average capacity for the year. The weekly reports which were instituted at the beginning of this year prove quite illuminating. They show that while the rating of a plant's capacity is done with more or less skill and definite knowledge, it varies from time to time. The reports show for each week both the rated capacity and the actual production. At a number of plants the ratings have varied according to the kind of coal they were using. During the railroad blockade of last winter some were forced to take coal that was not their choice, and their ratings were below normal for the plant. The rated capacity at the beginning of the year, given the choice of coal, was about 500,000 net tons a week. When operations became what may be considered substantially "normal," production turned out to be rather regularly about 90 per cent of rated capacity, there being an average sprinkling of plant repairs, little interruptions in coal supplies, labor difficulties, etc., that accounted for 10 per cent.

The first week in July a landmark was passed, the output for the first time being a half million tons; 502,666 tons, to be exact, with a rated capacity for the same week of 556,592 tons. There had been such an increase in the half year that the expected production, under normal conditions, would be increased by very nearly 50,000 tons, or fully 10 per cent in the course of six months. Starting the year with a rated capacity of 500,000 tons a week the industry promises to end it with about 615,000 tons capacity, from which it may be said that the expected production, at 90 per cent of rated capacity, promises to increase from 450,000 tons a week to fully 550,000 tons a week; and 1919 will show its own further increases. The rate of production at the close of 1918 should be nearly 30,000,000 net tons a year, against 22,600,000 tons actually produced in 1917. Assuming the actual production in 1918 to be 26,000,000 tons, which seems a fair guess, it may be said that in 1914, four years earlier, the output was not one-half as great; in 1909, nine years earlier, it was not one-quarter as great; in 1904, 14 years earlier, it was not one-eighth as great.

Of course there remains a great loss in volatile elements by the fact that the beehive process is still the predominating one. The weekly output of beehive coke, unlike that of by-product coke, varies so widely that a precise statement cannot be made of the average rate of production, but the average of the latest six weeks for which there are statistics at this writing shows a weekly average of 620,000 tons. To what extent the increase in by-product coke production will decrease the beehive production remains to be seen. Conditions are somewhat confusing and it is impossible to determine just how much coke the blast furnaces and other consumers will require. Much of the coal, moreover, that is used in by-product coking is drawn from beehive coking regions, and if the supply of coal controls, the beehive ovens will be closed when by-product ovens are completed, even though the preference would be to operate both. The balance of probability seems to be that if the by-product industry reaches a rate of actual production of 600,000 tons a week by the end of the year, the production of beehive coke will have dropped to less than 600,000 tons, so that then by-product coking will at last predominate. At August 1 the proportions seemed to stand about 55 to 45.

Readers' Views and Comments

Molecular Physics of Ore Flotation

To the Editor of Chemical & Metallurgical Engineering

SIR:—I note the communication from G. W. Van Arsdale in your issue of July 15, in which he offers a correction to a statement made by Mr. Anderson and myself in your issue for June 1, 1918.

In the absence of Mr. Anderson who is now in the training camp with the army engineers, I shall undertake a brief reply.

When I read the part of Mr. Van Arsdale's paper to which he refers, my mind reverted to ancient literature—ancient in terms of the age of American literature on flotation. If the reader will refer to the *Mining & Scientific Press*, vol. 3, p. 544 (1915), he will see that I once fell a victim to this same incorrect definition of surface-tension to which Mr. Van Arsdale refers. I soon discovered my mistake and hastened to correct my error, and the correction appears in vol. 112, p. 315. It was indeed a great surprise to me to find one of our leading contributors to the literature on flotation giving credence to this erroneous definition by saying: "As a matter of fact it can easily be shown that a square centimeter of water will support much more than this weight." I understand from this that Mr. Van Arsdale proposes to apply a factor, and further, that he declares that the factor shall be greater than unity. I see no element of scientific fact in this statement, because if, for example, the angle of contact is zero, the degree (factor) of flotability is also zero. For the explanation of this fact I can only refer to the article containing the paragraph with which Mr. Van Arsdale differs.

I regret it if Mr. Anderson and I have said anything that puts Mr. Van Arsdale before the readers as the chief, or only, transgressor of facts. I wish to take this opportunity to state that if a list were to be made of those who have mis-stated principles of flotation, my name should be included. In short, I believe that the only one who has not made mis-statements is the parasite who has stated nothing. There is no place in the study of flotation for the man who does not make mistakes. I once found justification in the literature on colloid chemistry for adhering to a theory, to wit, that all flotable bodies were surrounded by a liquid surface-tension film when submerged. Our study of flotability, a part of the results of which are contained in our article to which Mr. Van Arsdale refers, has convinced me that this theory is untenable.

Seattle, Wash. WILL H. COGHILL.

Flotation Apparatus

To the Editor of Chemical and Metallurgical Engineering

Sir:—An error has apparently crept into the minds of various writers to the technical magazines to the effect that the Towne-Flinn flotation patents concern only the cylindrical type of machine used at several demonstrations, and cuts of which have appeared at various times in the magazines. Also a parallel error arose to the effect that we used only a carborundum stone as a porous medium, when, in fact, a canvas bottom was among the first used in any of the various types of machines we designed. It would seem only fair to the late Mr. Robt. S. Towne and myself to state the truth at this time.

We were led into the pneumatic process from our observations while trying to develop an acid-proof filter in 1908. At that time, in cleaning our filter medium, which chanced to be carborundum stone, we reversed the air and blew through the stone. While doing this both with canvas and porous stones, we noticed the beautiful bubble screen and the action of the sulphide present with the bubbles formed. At about that time we were also carrying on investigations with the Elmore and Murex processes, and so were quite familiar with oil processes then suggested for use. In our experiments we used the wood distillation products so commonly demanded now in flotation work. However, it was not until a later date that we developed the "bubble column process" or the pneumatic process as now carried on. Among our earliest types of machines were the cylindrical, step-cone and what we called the Type B or flowing-type machine. This last machine was remarkably similar even in small details to the so-called Callow type which was developed by Mr. Callow at a later date. In the early days certain large mining groups in our country became very much interested in our pneumatic process and a mutual understanding arose that we would demonstrate it at one of their plants in counter-distinction to the beating or froth process which was just coming into prominence, and it was with this idea of demonstrating a process and not any special type of machine that Mr. Towne agreed to their request. His idea was to avoid any competitive tests between one machine and any other, but to give a demonstration of the pneumatic process as against the Minerals Separation process. Unfortunately delays crept in from sickness and other reasons, and the greater part of a year passed before we could carry out these plans. Litigation arose; moreover, at this time the Callow machine made its debut at the National Copper Company's mill.

We were convinced that the bubble column process had advantages over the froth process and were granted our claims for a process patent by the Patent Office. Being assured of this and being advised by our lawyers that we were fully protected, we did not push the patents for the various machines as actively as we should have done. This, of course, brought about interferences in the Patent Office with Callow, Cole and others. Mr. Towne's death in 1916 stopped our active work.

While the testimony was being taken in the interference case between Callow and ourselves in 1917, a very satisfactory agreement was arrived at, and we sold our basic patent and machine applications to strong interests. This seemed a wise policy, as otherwise years of litigation might have arisen and further disturbed the mining world. If we had followed out

our first impulse we would have given the public the entire knowledge and result of our experiments in the fall of 1912, and in fact had started to write an article for publication, but came to the conclusion that it would be wiser not to do so. We did and do yet maintain that our basic patent claims will prevent the use of any pneumatic machine without our permission, but of course that can only be decided by the courts.

In making these statements, I do not want to detract from Mr. Callow's glory in pushing his ideas and advancing the art as he has. Because of Mr. Towne's death and the selling out of our patent applications, I withdrew from any active part in the flotation field with regret, as it certainly contains much of interest worthy of scientific investigation.

Our use of the carborundum stone came about from the fact that we felt sure that some way would be found to clean the air blown through the stone, for our observations led us to believe that the blanking of the air passages came from deposits on the lower sides and not on the upper surfaces. Again if the bubbles be examined in a glass tubing it becomes apparent that more bubbles were formed by passing the air through stone than through a canvas bottom. As the efficiency of the process depended on bubbles, it seemed to us at that time that the thing to do was to use the one which formed the most. But by no means were we tied down in our patents to the use of any one kind of porous medium, and felt that the best type of machine and bottom could best be decided on after a long run in the mill. As to the capacity of any machine, it seems to vary with the ore and class of material treated. I must say frankly that I am not one of those who think that the pneumatic process is the only process, for I think that there are ores where the froth process seems to give the best results, and in other cases the pneumatic.

In closing, I will say that we tried passing H_2S and CO_2 gases as well as air through the bottom.

Newark, N. J. F. B. FLINN.

Recovery of Molybdic Acid for Steel Mills

To the Editor of Chemical & Metallurgical Engineering

SIR:—The following method for the recovery of molybdic acid from the analytical filtrates of phosphorus determinations has proved very economical as well as highly desirable in maintaining a supply of that reagent.

The method consists of the precipitation of the molybdic acid from the ferric nitrate solution with an excess of phosphate. Five times the theoretical amount of phosphate is added to the boiling solution. The filtrates from 3500 cc. of ammonium molybdic solution are heated to boiling and a solution containing 200 grams of commercial sodium phosphate added. The precipitate is allowed to settle and after the solution is decanted is transferred to a large mouthed bottle. When sufficient yellow precipitate from several precipitations is obtained, it is washed by decantation, transferred to a dish, the water evaporated off and the precipitate dried on a sand bath. According to the commonly accepted formula for the yellow precipitate, it contains 92% MoO_3; 210 grams would contain the same weight of acid as ½ lb. of 85% molybdic acid. Accordingly for the precipitation of the molybdic acid solution, 210 grams of yellow precipitate are weighed and 800 cc. of water added, followed by 600 cc. of ammonia. The solution is cooled and 35 grams of magnesium nitrate, dissolved in 100 cc. of water are added to precipitate all the phosphorus. After the solution has stood for some time, it is filtered and the precipitate is washed with 100 cc. of water or dilute ammonia. The filtrate is added to 1900 cc. of 1:1 nitric acid, the total volume being 3500 cc. and containing the usual amount of ammonia and nitric acid. W. H. LYNAS.

Columbus, Ohio.

Research Preparedness in the Zinc Industry

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read the interesting article by Parker C. Choate, under the above heading, in the July issue of your journal. I agree with the majority of his deductions and proposals, while some seem somewhat obscure and require further elucidation, even to one familiar with both the technical and practical side of zinc metallurgy. This is perhaps logical, in view of the radical changes proposed. I would like to know, for instance, how he proposes to extract the lead, silver and other valuable metals from the raw sulphide by leach electrolysis; also further particulars on his "volatile concentration" scheme, etc.

I do not agree with the statement that he sees little value in making sulphuric acid. On the contrary, saving the sulphur by making sulphuric acid enables the modern smelter works to survive hard times and close smelting margins, which will compel many of the antiquated plants to close down sooner or later. When it is considered that for every 100 tons of 60 per cent blende roasted in those plants, approximately 30 tons of sulphur is discharged into the atmosphere and lost, the waste becomes appalling, especially at the present time when every ton of sulphur is needed for the successful prosecution of the war. In pre-war times the sulphur value was rated at about $1.50 per ton of ore, and at present it is safe to say that it is worth not less than $5. Indeed, figuring brimstone containing over 99 per cent sulphur at an average value of $30 per ton, a zinc concentrate containing 30 per cent sulphur ought to be worth $7.50. Of course, I note Mr. Choate's plan to recover the sulphur from the calcium sulphide formed during distillation, so it would not necessarily be lost.

The writer has had no experience with briquetting the charge, but from a theoretical point of view, it seems a very promising line of investigation.

Mr. Choate's statement that pulverized coal will be found a most efficient auxiliary, is very much to the point. Years ago, while the writer was connected with a zinc smelting concern, he was first to suggest powdered coal for zinc smelting, before its recent general appreciation. The idea was taken up by the management, but the writer was given no opportunity to assist in its development during the later stages, as certain members of the management wanted to take all the credit for their own aggrandizement. This is the sad story of research in some companies at least, with non-technical superiors. ERIC JOHN ERICSON.

Chicago, Ill.

Solder Without Tin

To the Editor of Chemical & Metallurgical Engineering

SIR:—The following notes on solder may be of interest in view of the scarcity of tin and the necessity of substituting for it wherever possible. The notes are taken from the records of experiments on a somewhate different subject and are consequently incomplete.

LEAD-CADMIUM

The lead-cadmium alloys possess some desirable properties as solders and furnish the base for addition of other metals, giving solders of different characteristics. The melting points of the lead-cadmium alloys are shown in the diagram, Fig. 1. The final hardening temperature of these is above the melting point of ordinary solder. However, this would constitute an advantage for many purposes.

The following tests show the relative strengths of joints soldered with lead-cadmium alloys and pure tin at various temperatures. The tests were made by pulling apart two copper rods (½-in. diam.) which had been soldered end to end. The strengths of the joints are expressed in pounds necessary to pull apart a union of 1 sq.in. surface. The tests at elevated temperatures were made by immersing the solderd pieces in an oil bath. The 8 to 9 per cent Cd solder seems to be the best, cost as well as strength being considered.

RELATIVE TENSILE STRENGTHS OF JOINTS SOLDERED WITH LEAD-CADMIUM ALLOYS AND PURE TIN

Per Cent Cd	Melting Range, Deg. C.	Lb. per Sq.In. Breaking Strength of Soldered Joint at 20° C.	110°C.	150°C.	290° C.	245° C.
2	290–320	8,920	.....	....	....	....
2.5	270–300	9,700	.....	....	....	....
4	249–295	13,000	.....	....	....	....
6	249–285	13,250	.....	....	....	....
7	249–280	12,730	.....	....	....	....
8	249–278	16,650	10,350	5,650	3,570	2,080
8.5	249–275	17,300	.....	....	....	....
9	249–274	16,800	.....	....	....	....
10	249–273	14,000	6,120	5,540	3,030	....
20	249–259	12,350	.....	....	....	....
30	249–260	16,800	.....	....	....	....
50	249–273	12,380	.....	....	....	....
75	249–280	11,200	.....	....	....	....
Pure tin	232	14,100	6,450	5,350	3,770	(1,530 at 230°)
Pure lead	237	7,130	.....	....	....	....
Pure cadmium	321	6,620	.....	....	....	....
Half and half	180	14,800	.....	....	....	....

There are several difficulties which are encountered in the use of these solders. They cannot be used with the usual soldering fluxes, although glycerine gives fair results. The best flux which we were able to find is the following mixture of fused chlorides:

	Per Cent
Sodium chloride	11
Potassium chloride	14
Zinc chloride	65
Ammonium chloride	10

This may be used sparingly either melted or in dilute aqueous solution. This flux cannot be used in soldering complicated parts, such as electric motors, where it is impossible to remove all traces of excess flux. Metallic salts cause corrosion of copper on prolonged exposure to the air. With zinc chloride the corrosion takes place in a very short time.

Furthermore, the solder does not flow well on cold copper. It is necessary to heat the copper rather hot, and this often results in oxidation. The cadmium begins to oxidize about 30 deg. above the melting point of the solder. Consequently, it is necessary to maintain a very even temperature if the solder is to be used in a soldering pot. Under ordinary shop conditions, such use would not be practical.

LEAD-CADMIUM-TIN

Several references have been made recently to solder composed of lead, cadmium and tin. Our experiments with this solder were somewhat limited, but it was our experience that the addition of tin lowered the melting point of the solder as well as the strength of the soldered joint. The solder did not seem easier to flux than the lead-cadmium solders unless a large amount of tin

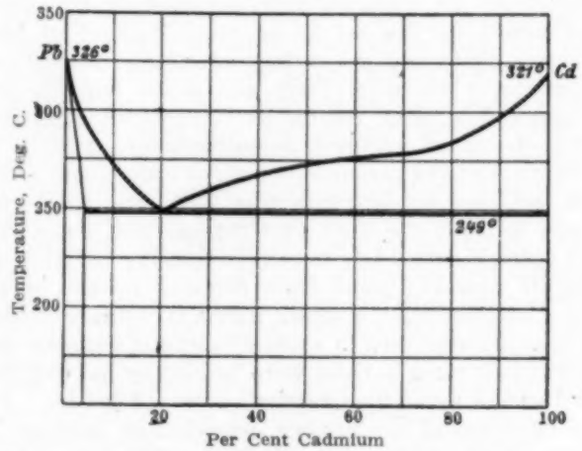


FIG. 1—MELTING POINTS OF LEAD-CADMIUM ALLOYS

were added. Metallic chloride fluxes seemed to be required in most cases where these solders were tried.

LEAD-CADMIUM-ZINC

Lead-cadmium alloys do not seem to dissolve zinc in quantities much above 1.5 to 2 per cent. Upon slow cooling excess zinc rises to the top bearing with it lead and cadmium. By stirring well before pouring, solders have been made with excess of zinc over that required for solution and the solders appeared to give good results. Tests of strength of soldered joints between copper rods showed values equal to those obtained by tin, half and half, or lead-cadmium solders at room temperatures. No tests were run at elevated temperatures. The fused chloride flux above mentioned may be used with these solders; but very good results were obtained by using a mixture of rosin, ammonium chloride and alcohol. The best solders appear to be those with a relatively small amount of zinc, especially where the soldered joint cools slowly or where the layer of solder is thick. A slight excess of zinc did not appear to lower the strength of the solder, those composed of 5 per cent zinc added to the 8.5 per cent Cd-92.5 per cent Pb above mentioned, giving excellent tests. Such a solder may be used with an iron where the work is not heavy. It solders well on tin, zinc, copper and iron. Clean tin sheet can be soldered without the use of a flux. The melting range is about 250-280 deg. C., depending upon composition.

There seemed to be but little trouble from oxidation even when the solder was overheated. Such solders would seem, on the basis of our limited experience, to be applicable to a wide variety of work.

Many of the data given above were obtained by Mr. Geo. P. Luckey, who has since entered the service.

CHARLES W. HILL.

Westinghouse E. & M. Co.,
East Pittsburgh, Pa.

War Industries Board Discourages Further Expansion of Electric Steel

MANUFACTURERS of electric furnaces in the United States have recently been confronted with the possibility of curtailing their business on account of the reported attitude of the War Industries Board against further expansion in the electric steel industry. When the matter was brought to the attention of CHEMICAL AND METALLURGICAL ENGINEERING we took the matter up through our Washington office and were informed that the Board was granting no new permits for electric steel plants in the restricted power districts of New England, and that the controlling factor was an ample supply of electric steel. On inquiry among electric furnace manufacturers we discovered that various reasons had been assigned to them, among others being the shortage of electrodes, shortage of power and a supply of electric steel in excess of demand. It was also ascertained that individual furnace manufacturers were acting on their own initiative in protest against the action of the Board, feeling that too drastic action might be taken that would vitally effect the furnace business. We have since suggested to all makers of electric furnaces in the country that they unite in the presentation of their side of the case to the War Industries Board, so that nothing will be done without thorough understanding of conditions, both by the Board and the manufacturers.

In the meantime the case for electric steel and the electric furnace has been brought to the attention of the Board through communications which we reproduce herewith in part.

Mr. C. H. BOOTH, of the Booth-Hall Co. has addressed the Board as follows:

> We wish to vigorously protest against this action on your part. As a member of the American Iron and Steel Institute, the writer was present at the spring meeting in New York City, and heard Mr. J. L. Replogle make a public statement that the steel demands for building of ships and the requirements of the Army and Navy were so great that it was very doubtful whether the entire steel production of the United States would be adequate to take care of the demand as fast as would be required. We cannot understand why conditions should have changed within the last sixty days to such an extent that you are warranted in discouraging the building of new steel capacity. The more electric furnaces that are placed in operation producing steel either in the form of high-grade alloy and tool-steels or high-grade steel castings, the more will the open-hearth and bessemer capacity be available for the manufacture of plates, structural steel and the other more common grades which are so much needed. In the steel casting field there will be released similar capacity for the manufacture of heavy castings where weight is the chief essential, or for the manufacture of ingots to be rolled into finished steel.
>
> GOVERNMENT SHOULD AID ELECTRODE MANUFACTURE
>
> Mr. DuBois has suggested that there is liable to be a shortage of electrodes, and for that reason the installation of new electric furnace capacity should be held back. On the other hand, we wish to point out that if the use of electric furnaces is encouraged, and not discouraged, it will stimulate the electrode industry. Why not aid the present manufacturers of electrodes to increase their capacity, or encourage the formation of new companies? With government aid, many problems much more complicated and technical than the manufacture of electrodes have been mastered and large outputs obtained. The manufacture of electrodes is quite simple by contrast and should be quickly and easily handled.

The merits of the electric furnace in conservation of materials were set forth by Mr. BOOTH as follows:

Conserving Manganese. The atmosphere in an electric furnace is either neutral or reducing. In either case there is no air draft to burn out the manganese contained in the steel or to oxidize the steel. Consequently less manganese need be added to make up losses and to deoxidize the steel. As contrasted with the electric furnace, the open hearth requires 50 to 100 per cent more and the steel converter 100 to 200 per cent more manganese. The electric furnace requires approximately 10 pounds of ferromanganese per ton of mild steel, so that the saving will be from 5 to 10 tons of ferromanganese to each 1000 tons of steel.

It is the usual practice in steel plants to add ferromanganese and spiegeleisen to steel, either in cold or pre-heated form. By melting the manganese in an electric furnace and adding it to the steel in molten form, the quantity of manganese needed to deoxidize the steel is greatly reduced. An article in the December 15, 1917, issue of METALLURGICAL AND CHEMICAL ENGINEERING, on pages 702-704, gives figures showing an actual saving of 44.3 per cent by adding molten ferromanganese as against adding pre-heated ferromanganese. The figures in question showed a consumption of 22.5 pounds of pre-heated ferromanganese per long ton of steel against 9.9 pounds of molten ferromanganese. This represents a saving of more than 560 long tons of ferromanganese per 100,000 tons of steel. Compared with adding ferromanganese cold the saving will be even larger.

The general use of the electric furnace for melting manganese additions to bessemer and open-hearth steel would result in reducing the requirements for manganese by nearly half.

Conserving Pig Iron. Both the open-hearth and converter processes when used for melting cold stock demand the use of pig iron and steel scrap. The proportion of pig iron to steel scrap depends upon the individual plant practice, but it may be said that approximately 40 to 60 per cent pig iron is used in converter practice and 25 to 40 per cent pig iron in open-hearth practice. The electric furnace processes alone allow the use of 100 per cent steel scrap without any pig iron being needed. The use of the electric furnace in place of the open-hearth and converter for melting cold stock wherever practical would result in a conservation of pig iron, releasing a large tonnage of pig iron for other purposes.

Conserving Plumbago. Plumbago is used extensively in the manufacture of crucibles. Crucibles are used extensively for the melting of brass and the production of tool-steels. The electric furnace is being used widely for the production of tool-steels, and there are still many plants using the crucible process which could change over to the electric process with profit. The use of the electric furnace for brass melting is still in its infancy and offers possibilities that may one day rival the use of the electric steel process. The use of the electric furnace in place of crucibles for brass and tool-steels would result in releasing a large quantity of plumbago for other necessary purposes.

Conserving Coke. The converter process of melting cold stock requires the use of a ton of coke to every 3 or 4 tons of steel. The electric process requires the use of no coke whatever. The use of the electric furnace in place of the converter for melting cold stock would release many thousands of tons of coke for other purposes yearly.

Conserving Steel and Iron. In every melting process there are losses of materials. Melting cold stock the loss will be from 7 to 11 per cent in large open-hearths, from 10 to as high as 25 per cent in small open-hearths and from 18 to 25 per cent in steel converters. In the electric furnace, the melting loss has been demonstrated to be approximately 4 per cent, this low figure being due to the absence of any oxidizing draft in the electric process. The use of the electric furnace in place of open-hearth or converter for melting cold stock would result in a saving of from 3 to 21 tons of steel for every 100 tons produced. This represents a conservation of natural resources.

The essentials to the operation of electric furnaces are electric power and electrodes. Of electric power, both steam and water generated, there is excess available throughout the country, particularly in the South, Middle West, Northwest, and West. Of electrodes there tends to be a shortage due to the expansion of

electrode manufacture not keeping step with the rapid expansion of the electric furnace industry. This is the only condition that must be taken care of in order to permit of installing additional electric furnaces and effecting the conservation of necessary materials as listed above. It is a condition easily remedied as the production of electrodes requires comparatively small investment and is a fairly simple process that has been thoroughly worked out in existing plants.

It is our contention:

First:—That the Government through the War Industries Board should encourage and aid the expansion of the electrode making industry, using methods similar to those used in increasing the output of other necessary materials.

Second:—That the Government should not restrict the installation of electric furnaces to the limited supply of electrodes, but should encourage the production of electrodes on a scale to keep pace with the growth of the electric furnace industry.

Third:—That the Government should encourage in every way the replacement of converters by electric furnaces for melting cold stock so that the considerable saving in pig iron, coke, manganese, and steel may be secured.

Fourth:—That the Government should encourage wherever practical the installation of electric furnaces for the melting of maganese additions to Bessemer and open-hearth metal.

Fifth:—That the Government should encourage the replacement of small open-hearth furnaces for melting cold stock and of crucible furnaces for brass and tool steel by electric furnaces.

Mr. VOMBAUR, of the T. W. Price Engineering Co., approached the matter from a different angle, and showed the advantages of the electric furnace in reducing the expense of transportation of materials and the release of rolling stock for other purposes.

We have a case in mind where 5300 hydro-electric horsepower is available on the Pacific Coast, where a large forge shop is now purchasing open-hearth ingots from the East. These are usually made from direct-metal refined in the open-hearth. The great saving in freight by making electric steel on the Pacific Coast rather than buying ingots in the East is indicated in the appended table, calculated on a 1000-ton basis.

	Tons
Iron ore, 50% Fe	2,000
20% crop of open-hearth ingots	200
Coke, 114% x 2200 tons (Forsythe)	2,508
Coal, at least 133% of coke	3,344
Limestone, 112% x 2200 tons (Forsythe)	2,464
	10,516
Ingots themselves	1,000
	11,516
Less scrap hauled for electric furnace plant from Pacific Coast ports, plus 10% for crop	1,100
Saving in tonnage	10,416
Mileage for railway haul	400
Ton-miles	4,166,400
Cost at one cent per ton-mile	$41,664

This case is typical of many others, and since the electric furnace in making steel of whatever nature usually uses over 95 per cent scrap, and in some cases all scrap, it is evident that it is one of the greatest economic factors in the iron and steel industry to-day. The situation represented in the tabulation does not consider the fact that from 17 to 19 pounds of either 70 or 80 per cent ferromanganese or an equal amount of ferrosilicon is required by the open-hearth furnace per ton of steel, while the electric furnace requires but half as much. Also the supplies required to keep an electric furnace going are much less than those required to continue an open-hearth or Bessemer in operation. Again, the higher ignition loss in the open-hearth furnace as compared with the electric furnace does not appear in the computation.

Government Needs Thousands of Draftsmen for War Work

THE vast activities of the Government in construction and maufacture in connection with the war program necessitate the employment of literally thousands of additional draftsmen of various kinds. The United States Civil Service Commission, whose duty it is to recruit these civilian positions, announces vacancies in large numbers of drafting positions. The filling of these positions is urgently necessary, as they have a direct connection with the war organization. Applicants will not be required to report at any place for examination, the ratings being based upon the applicant's education, training, experience, etc., as shown by the application and corroborative evidence. Full information and application blanks may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or with the secretary of the board of civil service examiners at Boston, New York, Philadelphia, Atlanta, Cincinnati, Chicago, St. Paul, St. Louis, New Orleans, Seattle, or San Francisco.

Following is a list of the drafting positions now open in the civil service, and the entrance salaries paid:

WAR DEPARTMENT

Construction Division

Title	Sex	Usual Entrance Salary	
Architect	M	$2500-$3500	a year
Structural designer	M	2400- 2700	"
Architectural designer	M	2100- 2700	"
Senior architectural draftsman	M	1800- 2100	"
Junior architectural draftsman	M	1200- 1800	"
Architectural tracer	M	1000- 1200	"
Quartermaster Corps and Ordnance Dept.			
Automotive engineer	M	2400- 7200	"
Automotive engineer	M	1800- 3000	"
Automotive draftsman	M	1400- 2000	"
Automotive tracer	M	1000- 1400	"
Signal Service			
Aëronautical mechanical draftsman	M	1200- 1400	"
Ordance Dept.			
Mechanical draftsman	M&F	800- 1800	"
Gauge designer	M	2000- 3000	"
Automobile draftsman	M	800- 1800	"
Apprentice draftsman	M	480	"

NAVY DEPARTMENT

Ship draftsman	M&F	$4.00- $6.88	a day
Architectural, mechanical and structural-steel draftsman (for ship work)	M&F	4.00- 6.88	"
Topographic and subsurface draftsman	M	4.48- 5.04	"
Radio draftsman	M&F	3 52- 6.00	"
Copyist draftsman	M&F	2.00- 3.44	"
Bureau of Yards and Docks			
Mechanical draftsman, armor and steel plant	M	4.00- 8.00	"
Engineering draftsman	M&F	3.04- 7.04	"
Bureau of Ordnance			
Mechanical draftsman	M&F	4.00- 7.84	"
Bureau of Construction and Repair			
Metal furniture draftsman	M	4.00- 6.00	"
Aëronautic draftsman	M	4.00- 5.04	"
Bureau of Steam Engineering			
Electrical draftsman	M&F	4.00- 6.40	"
Marine engine and boiler draftsman	M&F	3.28- 7.04	"

INTERIOR DEPARTMENT

Geological Survey			
Copyist topographic draftsman	M&F	$1100-$2000	a year

DEPARTMENT OF COMMERCE

Hydrographic and topographic draftsman	M	$1000-1200	a year
Apprentice draftsman	M	$60	a month

Chemical Exposition to Demonstrate American Independence

THE Fourth National Exposition of Chemical Industries, to be held in Grand Central Palace, New York, September 23 to 28, will demonstrate through the multitude of new products exhibited that the American chemist has answered fully the call made upon him since the present war began. It will prove conclusively that the chemists had the ability and the knowledge to develop the facilities for making practically all of the products heretofore believed impossible to be made here. Like our fighting forces they have accomplished in a few years what it required Germany nearly fifty years to do.

The exhibits will cover a wide range from the raw materials of the ground to the highest processes for refining and producing the finished product. The exposition will cover all the ramifications of the chemical and allied industries and men in every branch of industry will find therein the materials and machinery that they can apply in their operations. It will be an exposition for the utmost in efficiency, progress and inspiration.

Coincident with the exposition will be held a number of important conferences which will bring thousands of chemists to New York from all parts of the country. The theoretical and practical phases of chemistry will be not only discussed thoroughly but illustrated as well. Men prominent in various branches of industry, bankers and government officials will be on the daily programs along with the leaders in the chemical world. The exposition will bring together manufacturers of machinery, equipment, supplies etc., and with them will come men who will explain their operation. Many intricate machines built since the United States entered the war will be exhibited and these will prove interesting and instructive. Generally speaking, the exposition will be a big school of learning and any one who misses it will have cause for regret. The papers to be read will give some idea of the remarkable things being done by American chemists in the war and industry and these will also be of interest to the general public. Pressing chemical problems concerning many of the chief articles of domestic and foreign commerce will be taken up during the conferences and it is expected that these discussions will have an important bearing on the manufacture of articles that have been scarce and high-priced ever since the curtailment of American commerce with Germany and other countries.

The exposition is a war-time necessity, and regarding it as such each exhibitor is planning his exhibit so that it will be of greatest benefit to the country through the men who visit it, all of whom are bent upon a serious purpose—that of producing war materials in large quantities, and constantly increasing this production till the war has been won by the United States and her allies.

Manufacturers, large and small, are showing unusual interest in the exposition and applications for space have been so numerous that Charles F. Roth and F. W. Payne, the managers, have made special provisions for housing the displays. The various floors which will be utilized to display the products of the industry will be filled to overflowing with everything that is new and interesting in the chemical field.

The program for the exposition is now being prepared. There will be a series of symposia on the "Development of Chemical Industries in the United States, notably since July, 1914." This will embrace the period since the beginning of the European war, which by removing the source of supply for our domestic industries, inspired the development of our own chemical industries that are so efficient in the war. There will be pictures of many chemical, mining and related industries. In fact every field of endeavor from the products within, upon and above the earth with which chemistry deals, will be shown. There will be a series of films depicting carelessness, the destruction of life, wealth and resources, that show hazards and risks in industrial plants and how they may be overcome. The dangers of fire and explosives will be demonstrated and the prevention of disease by vaccines illustrated.

The complete program of speakers and motion picture program will be announced in our Sept. 1 issue.

Some sections of the South again are sending exhibits. Canada is taking the opportunity of presenting the matrials it has available for development by the chemist and financier. Technical and business men all over the country should give heed to these exhibits since they will show how they can meet the war time need. A section for the glass and ceramic industry has been added with which the American Ceramic Society is co-operating.

The advisory committee is composed of Charles H. Herty, chairman, Raymond F. Bacon, L. H. Baekeland, Ellwood Hendrick, Henry B. Faber, Bernard C. Hesse, A. D. Little, Wm. H. Nichols, R. P. Perry, H. C. Parmelee, G. W. Thompson, F. J. Tone, T. B. Wagner and M. C. Whitaker. Charles F. Roth and F. W. Payne are the managers.

The Sulphur Monopoly and Sulphuric Acid in Georgia

The Geologic Survey of Georgia has issued a bulletin of 229 pages, descriptive of the pyrite deposits of that state. Georgia has more sulphuric acid plants than any other state and has used small quantities of local pyrite for many years, ninety thousand tons being mined annually. This is highly important in regard to the fact that two companies—the Freeport Sulphur Co. and the Union Sulphur Co.—produce all the sulphur in this country, price data on which is given in the *Official Bulletin* of June 29, 1918, as follows:

> The cost of the Freeport Co. in 1917 was $6.15 per ton; in 1918 it is estimated that increases will bring the cost up to not over $9.50 per ton. In the first half of 1917 the Union Co.'s costs were $5.73 per ton. The average realization of the Union Co. in the first half of 1917 was $18.11 per ton, making a margin of $12.38 per ton. The manufacturers of sulphuric acid are paying in the neighborhood of $25 per ton, and some as high as $35 per ton, making margins of over $15 per ton for sulphur companies. The Freeport Co.'s balance sheets show an operating profit for the eleven months ending October 31, 1917, of $4,301,310, or 236 per cent on investment. On November 30, 1916, the company's balance sheet shows dividends declared of $925,000; on July 31, 1917, $1,850,000; and October 31, 1917, $2,600,000. Its surplus increased from $1,254,000 in November, 1916, to $2,543,000 in October, 1917.

These two companies have been to considerable patent litigation expense. Recently the Government took over the control of their operations so as to prevent a shortage of sulphur.

War Department Centralizes Purchasing Control

ORGANIZATION of the centralized purchasing scheme whereby the General Staff controls the buying of all commodities and supervises all contracts for the Army is rapidly progressing. Already assignment of purchases of a number of commodities has been made to the several branches of the War Department, and boards of review are passing on all contracts in order to insure uniformity of contract control and provisions. The general administration of the scheme is under the direction of Brig. Gen. Hugh S. Johnson, head of the purchase and supply branch of the division of purchase, storage and traffic of the General Staff of the Army.

In the past the various branches of the department have been buying their respective commodities through their own purchasing agencies, often bidding against one another for the same goods and frequently paying several different prices for the same article. The General Staff brought together a committee of representatives of the various purchasing agencies, and this committee is now engaged in standardizing the commodities needed and assigning to one branch of the department the purchase of each commodity. This standardization has progressed to the point indicated in the accompanying list, which shows the name of the branch intrusted with the purchase of about 150 items so far agreed upon. Others are being added to the list each day:

Quartermaster: Automobile drive, chain, iceboxes, burlap, non-skid chains, cotton cloth, cotton goods, cotton rope, silk fabric, rubber goods, woolen rubber goods, jutes, leather, linen, manila rope, needles, woolen goods.

Construction: Reinforcing bars, cement, clay products, electrical equipment and supplies, electric wire for heavy power, refrigerating equipment, sand and gravel, rough hardware, heaters, room heating equipment and supplies, plumbing equipment and supplies roofing material sprinkler systems, ventilating equipment, water supply equipment and fixtures, structural steel.

Ordnance: Chrome and ferro-manganese alloys, ammonium nitrate, artillery chain, barometers, dry batteries, blast furnace and steel mill products, cartridge cloth, coal gas products, coal tar products, cotton linters, forging equipment, hull fiber, flash lights, dry cell lanterns, nitrates, tin, pig tin, plate tin, platinum, sodium nitrate, stop watches.

Engineers: Arc search lights, chain, paint containers, gantry cranes, locomotive cranes, paint driers, electric gas generator sets, enamels, gas engines, mechanical rubber goods, japans, lacquers, mineral spirits, paint, steam shovels, turpentine, varnishes, linseed oil, railway equipment.

Signal: Electric wire, radio equipment, telephone and telegraph equipment.

Aircraft production: Aeroplane cloth, brass and copper tubing, electric wire and cable, clocks, aviators' clothing, compasses, wood distillates, gages, oil, air and gasoline, steel hangars, linen fabric for balloons and aircraft, thermometers, spar varnish.

Medical: Surgical dressings, surgical needles, medical thermometers.

Chemical and War Gas. Elastic tape, horse masks.

Thus, ferro-alloys or ammonium nitrate, regardless of their use or of the branch that uses them, are purchased by the Ordnance Division according to specifications laid down by that division. Any other branch requiring these articles makes a requisition on the Ordnance Division for the required amount. More than 70 per cent of the articles bought by the department are now being purchased under this system.

It has been decided by the Superior Board of Review of the General Staff that, wherever possible, fixed price contracts shall be used in the purchase of supplies for the War Department. In the exceptional cases, where it is clearly to the advantage of the Government that a cost plus contract be used, a cost plus fixed compensation contract is to be made, rather than a cost plu percentage contract.

Federal Regulation of Common and Skilled Labor

ON AUGUST 1 the supplying of war industries with common labor was centralized in the U. S. Employment Service of the Department of Labor, and all independent recruiting of common labor by manufacturers having a payroll of more than 100 men was diverted to the U. S. Employment Service.

While the restrictions against the private employment of labor apply only to common labor at the present time, these restrictions will, as soon as possible, be extended to include skilled labor. In the meantime, recruiting of skilled labor for war production will be subject to federal regulations now being prepared. This drastic change in the nation's labor program has been found necessary in order to protect the employer and the employed, to conserve the labor supply of the communities and to cut down unnecessary and expensive labor turn-over (which, in some cases, is as high as 100 per cent a week), and to increase the production of essentials.

Under the operating methods adopted, the country has been divided into thirteen federal districts, each district in charge of a superintendent of the U. S. Employment Service. The States within each district are in turn in charge of a State Director, who has full control of the service within his State. In each community there is being formed a local community labor board, consisting of a representative of the U. S. Employment Service, a representative of employers and a representative of the employed. This board will have jurisdiction over recruiting and distributing labor in its locality.

When the survey of labor requirements has been made and the aggregate demand for unskilled labor in war work is found, each State will be assigned a quota, representing the common labor to be drawn from among men engaged in non-essential industries in that State. These State quotas will in turn be distributed among localities. Within each locality, employers in non-war work, including those who are only partially in war work, will be asked to distribute the local quotas from time to time amongst themselves. Quotas by localities and individuals are to be accepted as readily as they are for Liberty Loan and Red Cross campaigns. This plan of labor quotas is a protection for all communities. The object is to keep any community from being drained of labor, and to use local supply, as far as possible, for local demand. The situation, however, is such that in certain cases some men may have to be transported over long distances.

The War Department has finally selected the so-called Broadwell site for the half unit of the ammonium nitrate plant to be constructed by the Air Nitrates Corporation at Cincinnati, Ohio. The cyanamid process will be used as in Plant No. 2 at Muscle Shoals, Ala.

Consumption and Conservation of Tin

THE tin consumption in the United States has increased steadiliy during the past decade and has been confined only by the limitations of ore supplies, a liberal sufficiency of which has never been located in the surface mineral formations of the earth. Except for the 140 tons of tin obtained near Nome, Alaska, practically the only source of tin ore supply on the American hemisphere comes from Bolivia. About 7500 tons of tin is being produced annually at the plant of the American Smelting and Refining Co. at Perth Amboy, N. J., from Bolivian concentrates, which amounts to about ten per cent of our present consumption.

The tin and terne plate industry and the solder and bearing-metal consumption, each take about one-third of our available tin. According to a statement compiled by the War Industries Board from returns obtained through the sub-committee on pig tin, the consumption of pig tin for different purposes in 1917 was as follows in gross tons:

TIN CONSUMPTION IN THE UNITED STATES IN 1917

Tin and Terne Plate	27,600
Solder	17,000
Babbitt, Bearing Metals	10,800
Bronze and Sn-Brass	4,800
Tin Foil	4,000
Collapsible Tubes	2,100
White Metal	1,764
APPROXIMATE ESTIMATES	
Chemical	2,570
Britannia Ware	1,500
Pipes and Fixtures	1,350
Hardware, Utensils	900
Rubber Filler	190
Galvanizing Alloy	150
Bullets	100
Type Metal	51
Bells	22
Not Known	1,350
Total	76,257

The Use of Substitutions

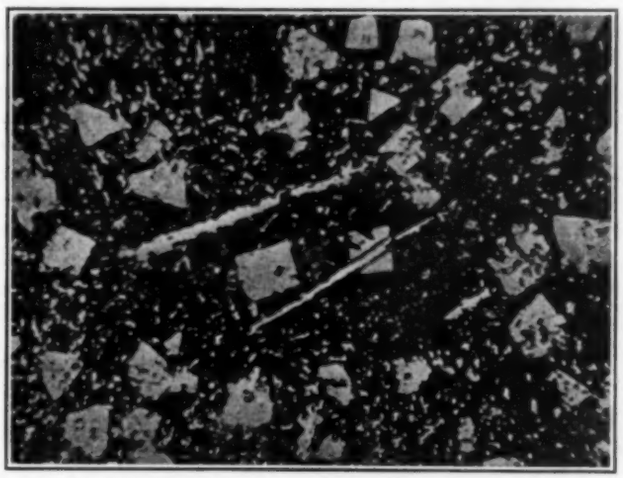
Asphalt and tar roofing have strongly relieved the demand for terne plate; parafined or parchmentised paper cartons and glass and pottery jars have come into almost as extensive use as the tin can in food conservation; and the tin alloys, such as solder, babbitt and bronze are being thoroughly studied to bring about a satisfactory product, with a minimum tin content. In regard to these alloys, the Tin Section of the War Industries Board reports:

> On account of the limited supply of tin available in the world to-day and because of the hazard involved in connection with our oversea imports upon which we depend for our requirements, and furthermore, because our war program calls for a very large tonnage of tin, it is imperative that we take immediate steps to husband our resources: First, by eliminating all waste; second, by substituting other metals wherever practicable; third, by reducing the percentage of tin used in various alloys just as far as possible, and finally, by recovering larger quantities.
>
> The War Industries Board has conferred recently with representative manufacturers of babbitt and other bearing metals, solder and miscellaneous tin-alloy products for the purpose of explaining the present situation, and in order to obtain suggestions as to the most practicable methods for conserving tin. In cooperation with the Bureau of Standards, a number of experiments have been conducted. . . .
>
> The accompanying statement reports some of the findings of the Bureau of Standards resulting from their experiments and from inquiries made among a number of large manufacturers and consumers. We realize that these suggestions cover only a few means of reducing our consumption of tin. The War Industries Board will gladly welcome others, particularly as it is expected that each recipient will be influenced in his approach to the problem by consideration of the special needs of his own line of products and manufacturing equipment. It is hoped that the very widest possible use will be permitted of any original findings that may result from a careful study of the problem.

Tin-Base Bearing Metals

Tin-base bearing metals are known in the trade as Babbitt Metals and are divided into three classes: 1. Tin, antimony and copper alloys. 2. Tin, antimony, copper and lead alloys. 3. Tin, copper and zinc alloys. In general they are less easily compressed than the lead-base metals. This resistance to compression is due to the relative content of antimony and copper of the bearing alloy, which are not only the hardening and wear-giving constituents but also form a crystal structured skeleton which is covered over by the soft, tough, tin bonding crystals.

Fig. 1 illustrates babbitt metal magnified to fifty diameters. The light crystal cubes are the hard grains of tin-antimony, while the needle-like grains are the



TIN-COPPER-ANTIMONY BEARING METAL

particles of antimony-copper alloy. The dark parts are the depressions in the surface due to the removal of the tin by the etching acid[1].

In the days of Isaac Babbitt the best known soft metal alloy was a high-grade pewter of the following composition: Copper 3.70 per cent, antimony 7.40 per cent and tin 88.90 per cent; and it was with this pewter that he initiated "babbitting" with the result that the name "Genuine Babbitt" became famous in engineering parlance. In modern practice the copper and antimony content have been increased to as high as 20 per cent, with 80 per cent tin for very hard babbitts. Many specifications now in existence call for virgin tin (Banca or Straits), where, as a matter of fact, just as good binding qualities would be obtained from a second quality pig tin with minor lead, etc., impurities. Lead has the property of lowering the melting point forming an entectic at 36 per cent tin, but the tin should preferably be over 50 per cent, antimony not less than 12 per cent and the copper not less than 3 per cent.

Parson's white brass, which consists of 62 per cent tin, 35 per cent zinc and 3 per cent copper, is largely used for marine and automobile bearings. Its disad-

[1] "Chemistry of Materials," Leighou, page 187.

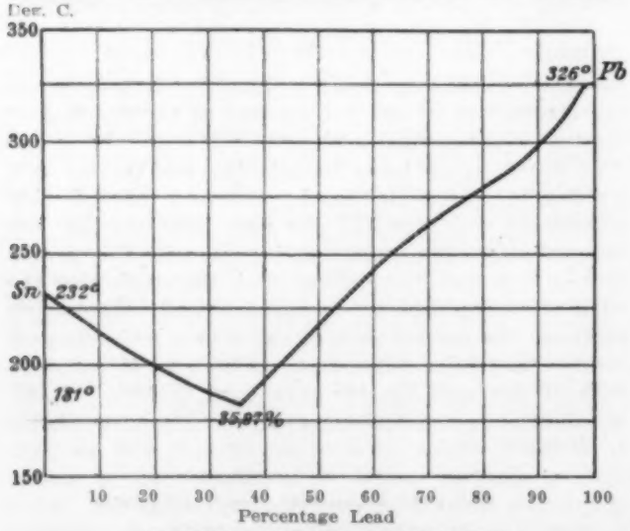
vantages lie in the fact that it has to be poured at red hot temperatures, is very sluggish due to the oxidized zinc skin, and has to be cast heavy, not filling into thin sections well. Perhaps the greatest and best means of conserving tin in the bearing metal industries will be to minimize the thickness and size of babbits instead of trying to substitute extensively the tin content of the best bearing alloys with lead or zinc. At present, the designing practice is governed almost entirely by the margin of heat needed to counteract the chill during the pouring operation so that a secure bond will be obtained as well as a solid unified mass. The bearing seats are best attached by previously tinning in the presence of a soldering flux (NH_4Cl-$ZnCl_2$-HCl-water) with powdered tin[2]. If the chill of the iron parts has been removed by moderate use of a blow lamp, very great extremes may be reached in the reduction of the thickness of the babbitts.

Solders

Over one-fifth of our tin is used in the manufacture of solders, ranging from 90 to 36 per cent tin. While the greatest care has not been used in minimizing the tin content of the alloy, most important developments have been made in preventing waste in application through the use of excessive amounts by means of electrically heated soldering irons, automatic solder-wire feeders, etc. Other metals such as cadmium have been tried as substitutes but are not of practical economic use. Perhaps electric welding and spinning operations will eventually be used more extensively, especially as tin actually becomes very scarce and costly. Fig. 2 gives the melting point curve of lead and tin[3].

Detinning Scrap—The Tin Cycle

Very many processes have been proposed for the recovery of tin from waste tin plate scrap and cans gathered by the municipal garbage systems. Ordinarily, all this class of metal is fused in a furnace



MELTING POINTS OF SOLDERS

for such castings as window weights and manufactured iron products which the brittling action of the tin does not greatly affect. Many processes for recovering the tin and solder have been tried out and some of them were profitable at a time when tin sold for as low as 37 cents per pound. These processes[4] may be divided into three groups: Mechanical, chemical and electrochemical. Most interesting of these is the catalytic action of the allotropic powder form of tin, gray tin, which forms spontaneously at low temperatures and acts catalytically as a detinner at temperatures below 20°C.

The only processes in commercial operation are the low pressure dry chlorine and the sodium stannate methods. The Goldschmidt Detinning Co. recovers over two thousand tons of tin per annum by these processes, on which they hold patents. Because iron is more electro-positive than tin, methods depending on acid solvents are failures. Copper sulphate, stannic chloride, etc., will dissolve tin, but as soon as iron is exposed, the desired reaction discontinues in favor of the solution of the iron. The chlorine process fails when water is not eliminated for the same reason—HCl being formed and the iron becoming the active material. Ammonium and sodium salts of tin give a cation not active to iron and prove practical for wet processes. The handling operations are of extraordinary difficulty, and this alone probably accounts for the limited success of detinning adventures and the extensive creation of the tin cycle.

[2]See Epicassit, *Met. & Chem.*, Vol. XVI, No. 7, Apr. 1, 1917, page 403.
[3]P. N. Degens, *Zeitschrift Anorganishe Chemie*, 63, 212, 1909.
[4]*Met. & Chem.*, Vol. XVII, No. 4, Aug. 15, 1917.

Assets of Four Corporations for Sale

A. Mitchell Palmer, custodian of enemy alien property, has directed that the following property be placed on sale:

Berger & Wirth Company of Brooklyn, N. Y. This company was organized about 1909 under the laws of New York for the manufacture of printers' and lithographers' inks. The head office of the company is at 5860 Columbia Heights, Brooklyn. The concern was owned by Emil Worlitzer, whose residence is in Leipsic, Germany. Berger & Wirth own many valuable processes, formulas and equipment for making inks.

G. Siegle Company of Rosebank, Staten Island, New York. This company is a large importer, manufacturer and seller of colors and other chemicals. It was organized under the laws of New York, April 4, 1904. The authorized capital stock of the company is $250,000, all owned by the G. Seigle Company, a German corporation located at Stuttgart. The plant of the company is located at Chestnut Avenue, Rosebank.

A. W. Faber, Newark, N. J. This company is the American branch of the A. W. Faber Co. of Stein, Bavaria, where it started its crayon business in 1761. It was owned by Alexander Count Faber-Castell and his wife, Otillie Countess of Faber-Castell of Stein, Bavaria. Since 1900 the offices and factory of the American branch have been at Dickerson and Hecker Streets, Newark, N. Y. The manufacture here has been limited to rubber erasers and bands. Henry Fera, Jr., has been general manager of the firm and attorney for the owners.

George Beuda Co., Boonton, N. J. This company manufactures bronze powders and is a branch of the same company at Fuerth, Bavaria, which was established in 1824. From 1905 to 1915, the company imported semifinished material direct from their German works. When the European war cut off all importation, the manufacture was continued from scrap brass.

Cleveland Meeting, American Chemical Society

Secretary Parsons announces that the fifty-sixth general meeting of the American Chemical Society will be held at Cleveland, Ohio, September 10 to 13, 1918. A council meeting will be held on the afternoon of September 9, and the council will be entertained at dinner at the University Club by the Cleveland Section. On Tuesday there will be a general meeting at the Hotel Statler, which is to be headquarters. A dinner will be given in the evening at the Statler Hotel, followed, after a convenient interval, by a smoker at the same place. Divisional meetings will be held on Wednesday morning and all day Thursday. On Wednesday afternoon trips will be taken, probably as follows:

A—Sanitary trip. Sewage disposal experiments. Water filtration. Garbage disposal.

B—Steel industries. Blast furnaces, by-product coke, steel, Bessemer, and open hearth.

C—Industrial tour of Cleveland, including all the manufacturing centers, but only a few stops.

D—Trip by special cars to Oberlin.

In the evening the President's address will be given and this will be followed by a reception at the Hotel Statler.

After the divisional meetings on Thursday, automobile trips will be taken to one of the country clubs for dinner and to the Cleveland Museum of Arts. On Friday a special excursion is planned for Akron, Ohio, where there are interesting rubber, pottery, soda, match, and other factories. Luncheon will be served in Akron and the party can leave for home from that city.

The Cleveland chemists are arranging special entertainment, not only for the men but for the ladies who may be present, and every effort is being put forth to make the meeting a success.

Special symposia are being arranged by the chairman and secretaries of divisions and it is believed that an unusual opportunity will be given in these active chemical times for chemists to get together and exchange views and ideas, many of which cannot at present be published.

Excess Sulphuric Acid in Britain

After a year's consideration, a governmental committee makes the following recommendations for providing an outlet for the surplus acid to be expected on cessation of hostilities, according to the British *Board of Trade Journal:* Every possible step should be taken to extend the use of fertilizers. Farmers should be educated by lectures, demonstrations and experimental plots. Cheap freights should be arranged. A joint committee of zinc smelters, acid and fertilizer makers should endeavor to introduce Government-made acid to the market so as to produce a minimum of disturbance and to suggest means whereby the erection of new acid works to deal with the gases from zinc concentrates can be avoided. The following recommendations for the relief of present owners are made: that for the purposes of taxation, the rate of depreciation on acid plants should be increased to at least ten per cent, retroactive to Jan. 1, 1915; that a government committee determine a method of scrapping old plant, government compensation to be paid on the basis of the value as a going concern, less scrap value; and that a reasonable rate of interest be allowed on plants which should be closed rather than scrapped. General recommendations of special intrest to chemists are:

(*a*) In view of the importance of scientific control of chemical operations, we desire to draw attention to the need for improving the status of the technical chemist. We consider that it is essential to the success of the chemical industries of the country that the value of men of liberal education who have specialized in chemistry and its cognate sciences and have experience of manufacturing operations should be more adequately recognized.

(*b*) We further recommend that the very complete data as to costs of production in acid manufacture and other chemical processes obtained by the Department of Explosives Supply during the war should be given as wide circulation as possible throughout the chemical trades, with a view to encouraging the more general adoption of a more systematic study of manufacturing costs.

Heyden Chemical Works Seized by Alien Property Custodian

The second largest corporation of its kind in the United States was seized by the Alien Property Custodian when on July 29 he took over the Heyden Chemical Works at Garfield, N. J. It is claimed that the real owner of the business was Chemische Fabrik von Heyden of Germany, and that the true ownership was misrepreented or concealed. The following have been appointed officers and directors of the company: President, Leroy Baldwin, President Empire Trust Company, 120 Broadway; Vice President, James A. Branegan, chemist, 1421 Chestnut Street, Philadelphia; Secretary, F. N. B. Close, Bankers Trust Company, 16 Wall Street; Counsel, J. Harry Covington, former Chief Justice of the Supreme Court of the District of Columbia, and Royal H. Weller, ex-Assistant District Attorney, of 31 Nassau Street, New York.

Chemists in France

Another tie joins France and American with the recent establishment of a French local section of the American Chemical Society.

Application has been made and granted for permission "to found in Paris a French section of the society covering the entire territory of France." The signatures on the application are those of distinguished French chemists intermingled with these of American chemists, who are now at the front in the service of our army. It is a joint brigading of French and American forces somewhat similar to that which has been affected recently between units of the respective armies. The successful result of the military union has already made itself evident on the battlefields of France and corresponding results can be predicted from this union of scientists.

Koppers Company Stock For Sale

Custodian of enemy alien property, A. Mitchell Palmers offers for sale the stock owned by Heinrich Koppers of Essen, Germany, in the H. Koppers Company of Pittsburgh, which does a large business in designing, building and operating by-products coke ovens. The company is capitalized at $1,500,000 and it is reported that 20 per cent of the stock will be sold.

The Sexagesimal Trade Units

Factors and Factor Interrelations of Gallons, Pounds, Cubic Feet, and Gravities

SINCE the international introduction of the C. G. S. system of units 67 years ago, men of scientific training in the United States and Great Britain have sought to have our ancient trade units superseded by this more mathematically convenient system, which was so gloriously installed by the French at the time they cast out king and royalty, removed the spell of antiquity and thus started an age of scientific development in every field of the mental environments of mankind. The origin of the English trade units are buried deep in an unwritten history of the early commercial navigators. The pound undoubtedly came from the Roman libre, as a consequence of the military colonization of England by the Romans.

The numerical foundation of these trade units as a whole can well be called astronomical—the sexagesimal system was very popular with the star-gazers of Egypt, not only because of having the factors 1, 2, 3, 4, 5 and 6, but also because they expected to find some ultimate mathematical relationship between these numbers and the movements of the heavenly bodies. The lore of the astronomer had its economic value as well, perhaps, as its origin and development in guiding the traveler on the starlit sands of the Sahara and finally over sea and ocean. The numbers 7, 9, 11, and 13 gave these semi-magicians much trouble as they were—and are still by some—regarded with mystery. However, the ancient navigator certainly had a much wider education in the "1 to 6" multiples than we of the fingers-and-thumbs decimal age on casual thought credit him with having. For this reason, it would not be out of place to critically examine these familiar old units with the same point of view with which one would, were he transposed back to the dawn of science when the magician was closely scrutinizing the stars.

After the number 60, 12 seems to have been of greatest importance, perhaps because of the number of moons in the four seasons, perhaps also because it was devisable by all of the "1 to 6" excepting 5. The dozen became the trade count, the foot was divided into twelve parts, the medicines of the magician were divided by twelfths, and so on. What bearing the fact that 12 wine gallons of water weighs approximately one hundred pounds had to do with the origin of that unit may be left open to conjecture, as well as the fact that 60 pints equals one cubic foot; however, prior to the time of the manufacture of measuring instruments by skilled tradesmen the handy seven-inch diameter by six-inch high cylindrical container may have had some numerical origin in magical logic.

That they worked diligently compounding numbers is a well-known fact, and while they did not originate a system of units having the conveniences of the decimal C. G. S. system, nevertheless, their units were not absolutely without preconceived relation.

Most important of these relations of volumes and weights with reference to water are:

1 cu.ft.	of	water	weighs	1000	oz. avoir.
1.6 "	"	"	"	100	lbs. "
12 gal.	"	"	"	100	" "
60 pints	"	"	equals	1	cu.ft.

The first relationship of ounces to cubic feet makes the solution of gas problems by Avogadro's Law as convenient with English units as with grams and litres. Thus an ounce-mol of any gas would make 22.4 cu.ft., etc. However, the C. G. S. system has taken undisputed possession of the laboratory, and it is only in trade metrology that any useful existing interrelations might prove valuable. Thus an ounce-mol of carbon dioxide, weighing 44 oz., would measure 22.4 cu.ft., as would 28 oz. nitrogen, 32 oz. oxygen, 29.2 oz. air, etc.

As the volume of 12 gallons or 1.6 cu.ft. of any substance weighs 100 times its gravity in pounds and the weight of any material to that of water is very easily determined by simple and well-known laboratory methods and for many substances is recorded in tables of specific gravities, it is easy to obtain weight per gallon or per cubic foot by pointing off the gravity two places and dividing by 12 for the former and 1.6 for the latter.

Thus if the specific gravity of a sample of H_2SO_4 were found to be 1.44, the weight would be, per gallon, $\frac{144}{12} = 12$ lb.; per cubic foot, $\frac{144}{1.6} = 90$ lb.

Of course the specific gravity must be relative to water at 39 deg. F., or 62.5 lb. per cubic foot, which is approximately an average for good city water, though chemically pure water is one-quarter of one per cent lighter.

When the Baumé scales are used, the formulae employed to obtain the specific gravities would be as follows:

Lighter than water.

$$\text{Sp.Gr.}\ \frac{60}{60} = \frac{140}{130 + \text{deg. B}}$$

Heavier than water.

$$\text{Sp.Gr.}\ \frac{60}{60} = \frac{145}{146 - \text{deg. B}}$$

Thus, with a sample of 66° Baumé sulphuric acid:

$$\text{Sp.Gr.}\ \frac{145}{145 - 66} = 1.835$$

$$\text{Cu.ft.} = \frac{1.835 \times 100}{1.6} = 114.6 \text{ lb.}$$

$$\text{Gal.} = \frac{1.835 \times 100}{12} = 15.6 \text{ lb.}$$

By way of illustration to show the probability of the immediate introduction of the C. G. S. units into our trade, the resolution adopted by the National Association of Manufacturers at their recent convention may be noted:

WHEREAS, the agitation for the adoption of the metric system has been again revived and is being vigorously conducted, and

WHEREAS, the 'British Committee on Commercial and Industrial Policy after the War' has made an exhaustive analysis of this question and concludes in language as follows:

> We are not convinced that the metric system is upon the whole even theoretically superior to the British system, and we are satisfied that the practical objections to the proposed change are such as to decisively outweigh any advantages which are claimed for it.

Therefore, be it

Resolved, that we regard the agitation for the establishment of the metric system as particularly untimely because of war taxation on manufacture, and because under present conditions the overwhelming activity of manufacturers in war work makes proper consideration of such a subject impossible. It is further

Resolved, that we endorse the work of the American Institute of Weights and Measures in opposing the adoption of the metric system.

The Manufacture of Carbon Electrodes for Electrometallurgical Purposes*

Raw Materials Suitable for Electrode Manufacture—Proportioning of Ingredients—Methods of Mixing and Firing—Testing the Finished Electrodes—Summary of Manufacturing Methods Used by Different Companies—Bibliography of Technical and Patent Literature

THE carbon electrode is the product of an industry which started about forty years ago. In the middle of the last century carbon plates and carbon pencils, principally as battery carbons, were made on a small scale, although manufacturing proper can only be considered to have begun about the '70's.[1] The credit for developing an industrial process of manufacture which is still used today in its general outline belongs to the Frenchman, Carré. In 1876 and 1877 he stated definitely the principal steps in his process: Grinding, mixing with a binding medium, pressing and afterward heating to incandescence. He introduced the idea of bedding the incandescent piece in coal dust and he was the first to manufacture artificial carbon industrially. The artificial carbons made at that time were used principally for illuminating purposes, but later they were employed for electrothermic processes. The industrial use of the electric arc in large furnaces as a source of heat, in the production of aluminium, the making of calcium carbide and ferro-alloys, as well as of electric steel, gave a great impetus to the manufacture of electrodes.

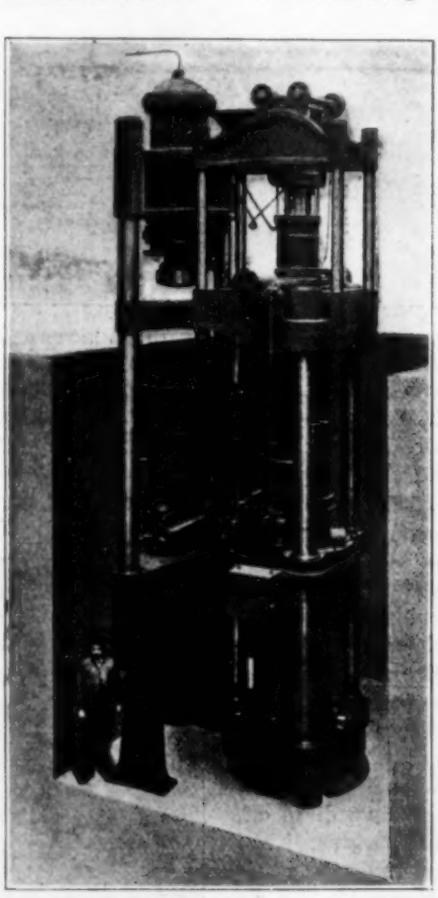


FIG. 1.—VERTICAL PRESS

The demands made by electrothermic processes on the quality of artificial carbon are quite different from the requirements for obtaining a steady arc in electric lamps. Diffusion processes, such as making carbide and aluminium, require principally great mechanical strength, good conductivity and small losses. At the same time, the requirements in regard to dimensions were considerably greater than was the case for the manufacture of arc carbons or battery plates. This made it necessary to adjust the manufacture to the working of considerably larger quantities of material, and thus the manufacture of artificial carbon entered the circle of big industries At the present time the furnace installation of the large firms is of such size that it can be considered among the largest ceramic kiln installations existing. The machinery used is manifold and of quite considerable size. This is especially true of the hydraulic presses, used in the making of large electrodes.

The following notes describe the processes used in some of the electrode factories, in so far as that is possible, following either the communications made by the respective factories or the data found in the literature. In general, the process consists in mixing the ground and cleaned raw material with tar, giving it the desired shape by pressing, and finally calcining the material to give it the required strength and conductivity. The manufacturing process is therefore in principal a very simple one, and in part is closely related to the general methods of ceramic manufacture. Whereas in the latter the binding medium is always a plastic clay, in the former the binding medium consists of pure carbon grains, the coke residue which remains after the calcination of tar or pitch-like substances.

The raw materials considered suitable for the manufacture of electrodes include all varieties of carbon found in sufficient purity and in a form which can be industrially used as such: Coke, charcoal, anthracite, lamp black, retort carbon, tar coke, petroleum coke and graphite. The proportioning of the quantities of the different ingredients and the size of the grain are naturally of decisive importance for the quality of the final product. The manufacture begins with the crushing of the raw material in case that is necessary. As these substances are usually quite hard, it is necessary to provide extensive equipment for graded crushing, grinding and screening. Only a few of the numerous mill constructions have proved satisfactory, because the wear on the machinery is considerable if the wrong kind is chosen, and the presence of metallic iron in the smallest percentages must be avoided.

*Translation from *Stahl u. Eisen*, 32, 1912, p. 1857.

[1]On the historic development of the manufacture of electrodes —see Zellner: "The Artificial Carbons for Electrotechnical and Electrochemical Purposes, Their Preparation and Testing." Berlin, 1903, published by Julius Springer; further Tehl: "The Manufacture of Carbons for Electric Lighting and Other Purposes." London: 1899; *Zeitschrift fur Elektrochemie*, 1901, 28, March, p. 516; *Elec. World*, 1909, v. 2, p. 682.

[2]See *Compt. Rondus*, v. 4; *Bull*, de la Societe d'Encouragement, 1877: H. Fontaine, *L'Eclairago Electrique*, 1877.

The raw materials are subjected to calcination so as to remove all gases and oily substances. The crushed raw material is then mixed with the binding medium, tar or pitch, and kneaded. It is then given the required cross-section in a lever press as shown in Fig. 1.

The pressed pieces thus prepared are subjected to a roasting and coking process in a gas-fired angular kiln, with exclusion of atmospheric air. The kilns shown in Fig. 2 are generally low furnaces constructed of the best refractory material in order to withstand continuous temperatures of 1500 to 1600 deg. C. The exclusion of air is accomplished by placing the electrodes into square or round chambers of very refractory material, and filling the space between electrode and chamber wall with carbon dust. The chambers are fitted with air-tight covers. The period of calcination varies according to the dimensions of the electrode, being from six to twelve days for the smaller pieces and from ten to sixteen days for the larger ones. The firing must be extraordinarily uniform as otherwise stresses occur in the electrodes which easily lead to the formation of cracks.

FIG. 2.—KILNS FOR BURNING ELECTRODES

During the first period of the calcination process the tar oils contained in the binding medium distil off, continuing up to the moment that red heat begins. Then the binding medium begins to coke and finally the whole mass begins to slag. The finished electrodes are removed from the furnace, and after complete cooling are examined for cracks or other faults, after which they are ready for use.

A German factory gives the following values for the physical and chemical qualities of amorphous carbon electrodes:

Specific weight	1.50–1.55
Specific resistance at cross-sections of from 25 to 3000 sq.cm.	45 to 100 ohms
Electrical coefficient of temperature of from 25° to 900°C	0.000318
Specific heat determined at 100°C	0.18–0.22
Compressive strength	230–410 kg./sq.cm.
Bending strength	51–81 kg./sq.cm.
Heat extension from 0–700°C	0.26% of the initial value
Heat conductivity for a cube of 1 cu.cm. at temperature falls from 130-20°C	0.24 heat unit/st.
Ash content	2.5–3.0%
Phosphorus	0.45–0.53%
Sulphur	0.90–1.10%

The process and installation of the Soc. Am. Electrometallurgic Procédée Paul Girod, Ugine, are as follows: The principal raw products used by this firm for the manufacture of electrodes are: (1) Retort carbon; (2) petroleum coke; (3) anthracite. Pitch is used as a binding medium. These various raw products[3] are used either separately or mixed in certain proportions, their selection depending upon the cost of production.

Retort carbon comes, as is well known, from obstructions formed in the retorts of gas plants. The ash varies from 1 to 3 per cent and contains little volatile substance. After its incineration, only small traces of ash are found and consequently this material can be used directly for the manufacture of electrodes without preliminary treatment. Analysis of retort carbon is approximately as follows:

FIG. 3.—RETORTS FOR DISTILLATION OF PETROLEUM COKE

	Per Cent
Ash	1.77
Volatile matter	0.46
Sulphur	0.73

Petroleum coke, however, is different. This is a residue obtained from the distillation of heavy oils or petroleum oils, and still contains from 5 to 8 per cent of

[3]On the raw materials for electrode manufacture; see also Zellner, *Stahl u. Eisen*, v. etc., p. 19-84.

volatile hydrocarbon. Hence it requires a special treatment consisting of further distillation before it can be used in the manufacture of electrodes. This distillation is carried out in furnaces with horizontal retorts similar in construction to the ovens used in gas plants (Fig. 3). Petroleum coke is heated in these retorts for about 6 hours at a temperature of 1000 deg. C., after which it contains only about 2 per cent of ash. In addition to this supplementary distillation, petroleum coke is subjected to a preliminary washing for the purpose of removing any soluble salt which it may contain. This work is carried out in chambers of 140 cu.m. capacity, there being six of these chambers at the plant. They are charged with coke and each of them is completely filled with water two or three times in succession so as to leach the soluble salt.

FIG. 4.—MILLS FOR WORKING RAW MATERIAL

FIG. 5.—PRESS

The composition of petroleum coke is approximately as follows:

	Before Washing, Per Cent	After Washing, Per Cent
Ash	3.09	2.83
Volatile substances	6.55	5.45
Sulphur	1.44	1.34
Chlorine	2.36	0.52

Anthracite is treated in about the same manner as petroleum coke because it also contains volatile matter. Its ash content amounts to about 2 per cent. The selection of the anthracite is more difficult than in the case of the two previously mentioned materials, because it is found to contain a strong admixture of iron oxide which is detrimental for the purposes to which the electrodes are applied. The composition of the anthracite used is ordinarily as follows:

	Per Cent
Ash	2.77
Volatile substances	6.30
Sulphur	0.79
Phosphorus	0.032
Iron oxide	0.27

After these materials have been treated for the removal of volatile matter they are passed through a crushing and grinding plant and broken into grains of a size between 2 and 3 mm. They are then packed into sacks and weighed and are ready for the manufacture of electrodes.

The tar which serves as a binding medium is a mixture of pitch and tar oil, the quantity ratio of which must be kept exactly. It usually has the following composition:

	Per Cent
Ash	0.15
Volatile matter	43.0
Carbon	56.85

The composition of this tar is determined by two methods, both of which are of equal value and can therefore be used as checks. According to one method the volatile constituents and the ash and carbon contents are determined. According to the other the viscosity is measured, by determining the time required by a certain quantity of the tar to flow through a circular opening of known dimension.

The raw materials are then mixed in a steam jacketed mixing apparatus. The quantity of tar used varies between 22 and 30 per cent, depending upon the manufacturing process, i.e. if the electrodes are to be pressed or squirted out by a special press.

When the mass is sufficiently mixed it is further worked in mills as shown in Fig. 4, so that it becomes very dense. It is then put into the first press, shown in Fig. 5. Here it is pressed in a cylindrical container and has the shape of a block when freed from its mold. Such a block weighs approximately 1200 kg. After leaving the stamp press the block enters another special squirting press, shown in Fig. 6, where it is molded under pressure of from 380 to 400 kg. per sq. cm[4]. The extruded blocks will furnish from four to eight electrodes of the required diameter.

After leaving the special press the electrodes are set into an annular kiln, shown in Fig. 7, where they are embedded in coke dust in a vertical position in special earthen vessels. The calcination results in the distilla-

[4]On the mechanical working of carbon, crushing, mixing, pressing, see Zellner, p. 85-173.

tion of the volatile portion of the tar used as a binding medium, and the remaining carbon combines with the original grains to form the electrode.

The kiln consists of about thirty chambers, each with six vessels. It is heated by gas furnished by two gas producers and is maintained at a constant temperature, rising from about 1100 to 1250 deg. C. It is of the utmost importance that the heating of the chambers should be regular and progress uniformly. The same is true as regards cooling. Any deviation from this rule means a failure in the product.

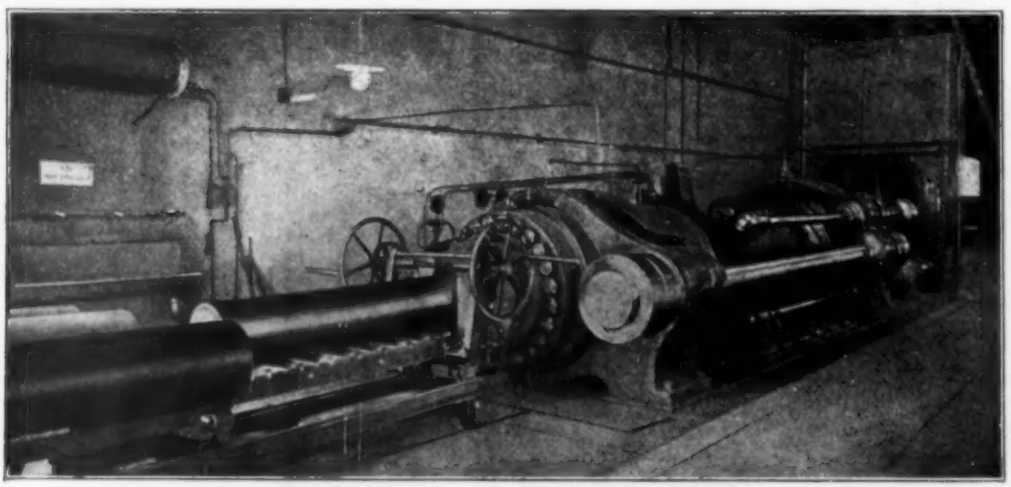


FIG. 6.—HORIZONTAL EXTRUSION PRESS

The results of analyses of the producer gas and the product of combustion in the kiln were as follows:

	Per Cent		
	Test I	Test II	Test III
At exit from gas producer:			
CO_2	4.5	6.3	3.9
O	2.2	2.3	6.9
CO	25.0	22.8	21.7
Combustion product of gases at exit from kiln:			
CO_2	12.1	12.4	13.8
O	5.8	6.0	5.4
CO	0.4	0.4	0.0

It will be seen that products of combustion contain a small surplus of oxygen. It is very difficult to keep all of the openings airtight, especially if the kiln has been used for some time. The combustion of the gases in this case was evidently good, as the carbon monoxide content never exceeds 0.4 per cent.

After removal from the kiln the electrodes are brushed and examined. They must show no cracks, and when tested by striking with a hammer must give a clear, pure tone.[a]

Some of the electrodes from each batch are taken for test and are examined for resistance in the test machine. Hitherto those tests were made by means of a milli-ampere meter, but that apparatus is too sensitive and is better suited for laboratory than for industrial purposes. The results obtained by this method were often impaired by intermediate resistances, as only weak currents were passed through the electrodes. It became necessary, therefore, to devise a machine which permitted of working with greater current and which yielded more exact and more uniform results.

The electrode factory of Dr. Albert Lessing, Nurnberg, describes electrode manufacture as follows:[a]

The raw material, which is retort graphite from gas plants, is carefully freed from all impurities by brushing. For that purpose the pieces, often weighing hundreds of pounds, are crushed in rock crushers into pieces about the size of the fist. They are then heated with exclusion of air to 1200 deg. C. so as to completely expel all volatile components. The pieces are then ground very fine and the powder is screened to uniform grains of the finest size, because it is of the utmost importance in the manufacture of electrodes that only very fine material should be used. The powder, free from dust, is very carefully mixed with tar, freed from water, and heated for several hours in mixing machines, after which it is allowed to stand for some time. The shape of the electrode is given, according to the installation of the plant, either in large stamping machines which press the material into the required form in the cylinders of the electrode press, or in these same cylinders the mass is compressed by hydraulic means. It is necessary to envelop the cylinder with a steam jacket because after cooling of the tar the mass is quite stiff and not very pliant. It is, therefore, necessary to heat the mass throughout to about 40 deg. C. When this temperature has been reached, a mouth-piece is fitted to the open end of the cylinder which has an aperture exactly corresponding to the shape of the electrode, with ½ per cent added on account of the shrinkage during the further working of the mass. The electrodes thus compressed under the highest pressure are left for several days exposed to the air, after which they have hardened so much that they can be handled quite freely without breaking.

The electrodes are then placed in large kilns of the annular kiln type, situated underground so as to avoid the heat losses. Here begins the most difficult part of the manufacture, namely, the calcination at a temperature of 1300 deg. C. During this treatment the greatest care has to be taken, and in the best factories fourteen days are required for gradually heating the electrodes up to the maximum temperature and for the cooling which follows. The following reasoning shows how important it is to heat the material slowly. Carbon is a poor heat conductor. If the heating proceeds rapidly the outer layers will have been burned hard while the inner core will not have been sufficiently heated. The purpose of the calcination is to remove the tar which was previously added to increase the plasticity of the material. With too rapid heating, the tar in the interior would distil later and destroy the outer crust.

[a] On the process of calcination (roasting), kiln, and kiln management, see also Zellner, p. 174-204.

[a] "Zeitschrift für Elektrochemie," 1903, 26, March, p. 260.

It is necessary to examine the carbon carefully to detect large cracks. Small cracks on the surface only, so-called fire cracks, are of no importance. A flawless electrode, calcined to the core, should give a full sounding, clear, strong note when tapped with a hammer, whereas an electrode with cracks will have a sound like a broken pot.

The electrical resistance of such electrodes must be within narrow limits. It does not exceed 400 ohms per sq.mm., and 1 m. in length with the heaviest pieces, and with increasing cross-section it falls to 80 and 100 ohms. For many purposes the great chemical purity is of importance. On the other hand, small quantities of ash are of no importance in electrodes used in the manufacture of calcium carbide, since the raw materials, lime and coal, carry proportionately larger quantities of impurities into the finished product. It is evident also that the very pure electrodes are correspondingly expensive.

Clacher[1] has described the manufacture of electrodes in the factory of the British Aluminum Co. at Greenock, Scotland, as follows:

1. The petroleum coke is roasted to remove all volatile substances and increase its density and conductivity.
2. The roasted material is crushed.
3. The crushed material is mixed with a binding medium in a steam-heated mixer.
4. The mixed mass is shaped.
5. The block is calcined in a kiln which requires five days; after cooling the blocks are brushed and placed in the warehouse ready for delivery.

The petroleum coke contains from 5 to 13 per cent volatile hydrocarbon which escapes in the process of distillation; it contains further a small quantity (about 2 per cent) of inorganic substance. It is usually furnished by the oil plant in pieces of large dimensions, which is of great advantage, as the small coke and dust always present easily clog the roasting kilns, and thus only a small quantity of them can be used in a charge.

The kilns are arranged vertically, the coke being charged on top and the calcined material removed at the bottom. Charging is done every two hours, and each half hour a charge is removed, the coke requiring five hours to pass from the throat to the bottom. The temperature of the kiln at its hottest part reaches about 2000 deg. C. The process is very expensive with the method used at present, since 30 per cent of the coke charge is completely consumed. The volatile components of the coke before calcination amount on an average to 8 per cent, so that 22 per cent of carbon is consumed to raise the temperature up to 2000 deg. C. The roasting was also done in horizontal retorts, the first cost of installation of which is greater, but the operation of which is more economical, the loss amounting to only 20 per cent. When the calcination was done in a flow of producer gas, the loss was somewhat higher than the percentage in volatile components of the material; the loss was 15 per cent with 10 per cent of volatile substances in the coke. The temperature is not so high as in the vertical retorts and does not much exceed 1000 deg. C.

After calcination the coke at Greenock contained 0.7 per cent of inorganic substances, as follows:

	Per Cent
Silicic acid	0.50
Iron oxide and alumina	0.15
Soluble sodium salt	0.05

The calcined coke is first crushed until the material all passes through a 9.5 mm. screen, after which it is ground to the exact powder grain size. This grinding is of the utmost importance. The quantity of fine and coarse grained powder must be in suitable proportion, so as to give a block of the highest density and least porosity. The following is a good mixture: 40 per cent of material screened through a 100-mesh screen; 15 per cent of material through a 60-mesh screen; 20 per cent through 30-mesh; 15 per cent through a 16-mesh, and 10 per cent through a screen of 8 to 16 mesh. The crushing is done in stone crushers and rapid running vertical mills. The cost of crushing at Greenock amounted to from 75c. to $1 per ton.

The following raw materials are used at Greenock:

1. The residue blocks of the aluminium ovens which contain about 2 per cent of inorganic matter, of which a little more than 1 per cent is silicic acid and iron oxide. These blocks are crushed in the usual way to the grain size of an 8-mesh screen. The composition of the material is as follows:

FIG. 7.—ANNULAR KILNS FOR CALCINING ELECTRODES

	Before Working, Per Cent	After Working, Per Cent
Ash	1.56	0.53
Soluble matter	0.33	0.17
Silicic acid	0.46	0.14
Iron oxide	0.26	0.14
Clay	0.39	....
Lime, magnesia, sulphuric acid	0.12	....

[1] "The Manufacture of Carbon Electrodes." *The Electrical Rev.*, v. 68, p. 99. *Met. & Chem. Eng.*, 1911, March, p. 137.

2. Retort carbon containing 2 to 4.5 per cent inorganic matter. After crushing to the grain size of an 8-mesh screen the inorganic substance fell from 3 to 0.75 per cent. The composition is as follows:

	Before Working, Per Cent	After Working, Per Cent
Ash	2.35	0.68
Soluble matter	0.10	....
Silicic acid	0.91	0.90
Iron oxide	0.62	0.96
Clay	0.41	0.08
Lime	0.17	....
Magnesia	....	....
Sulphuric acid	0.11	....

Crushed to the grain size of a 60-mesh sieve the composition changed as follows:

	Before Working, Per Cent	After Working, Per Cent
Ash	6.50	1.25
Soluble matter	0.17	counted in the difference
Silicate	3.55	0.38
Iron oxide	0.88	0.05
Clay	1.55	0.31
Difference	0.35	0.51

Welsh anthracite crushed to the grain size of a 10-mesh sieve showed the following composition:

	Before Working, Per Cent	After Working, Per Cent
Ash	2.08	0.57
Silicate	0.78	0.20
Iron oxide	0.32	0.12
Clay	0.43	0.12
Soluble matter and difference	0.53	0.13

The crushed raw materials are mixed with tar in steam heated mixing machines. The tar quantity used amounts to 22 per cent of the mixture. When taken out it has a temperature of 90 deg. C. The mixture so prepared is then put into a hydraulic press and pressed into blocks, which are left to lie one day. After they have hardened a little, they are brought into the kiln, which is heated with producer gas. The specific weight of the block after roasting was 1.63 as to 1.53 before roasting.

Ch. Louis[8] gives the following data in regard to the manufacture of electrodes: The raw materials have to be as free as possible from ash, sulphur and phosphorus. The average samples showed the following composition:

	Anthracite, Per Cent	Petroleum Coke, Per Cent	Retort-Carbon, Per Cent
Volatile matter	1.8	0.8	0.8
Solid carbon	95.0	98.0	94.6
Ashes	2.5	0.2	3.8

The materials are freed from volatile matter by heating in closed vessels, after which they are ground to grains of 0.5 to 1 mm. diameter. Dry pitch and desiccated coal tar serve as binding media. For some years past, a product sold on the market under the name of electrolytic pitch has also been used for that purpose. The quantity of binding media used should be as small as possible, as a rule from 10 to 15 per cent of the carbon used. The mixture is kneaded in mixing machines at a temperature of from 70 to 90 deg. C., then pressed by hydraulic boards into forms and finally very carefully heated. The highest temperature permissible is 1900 deg. C. The cooling process has to proceed very slowly and each electrode is heated from 8 to 10 days in the kiln[9].

The amorphous electrodes described herewith are artificial carbon calcined under exclusion of air from different varieties of amorphous carbon with the aid of a binding medium. Graphite electrodes, on the other hand, consist exclusively of pure graphite or the crystalline variety of carbon. They can be made in the same way as amorphous electrodes, with graphite as the initial material; or they can be made by transforming amorphous carbon electrodes into graphite electrodes by means of the electric furnace[10]. The graphite electrodes found in the trade are made exclusively by the latter process.

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[8]Ch. Louis: "Les Electrodes en Carbons et Leur Emploi Dans Les Fours Electrique," *Bull.* "Technologique des Anciens Eleves des Ecoles des Arts et Metiers," 1910, Feb., p. 232. *Revue de Metallurgie*, 1911. Extraits, p. 320. *Zeitschrift fur Electrochemie*, p. 377.

[9]See Brandt: "The Preparation of Carbons and the Manufacture of Electrodes"; *Chem. Ztg.*, 1901, Nov., 6, p. 980. Haber: Report on "Electrical Carbons" at The Paris Exhibition, 1900. *Zeitschrift f. angew. Chemie*, 1901, 19, Feb. p. 184. Norden: on "The Produces of the National Carbon Co.," Cleveland, at the exhibition at Buffalo, 1901. *Zeitschrift f. Elektrochemie*, 12, Dec., p. 1067. Strauss: "Manufacture of Carbon Electrodes at the Factory of the Soc. des Carbures Metalliques de Notre Dame at Briaucon." London, *Elec. Rev.*, 1901, 11, p. 927. After "Rev. Gen. de Chim. Pure et Appl." *Jahrb. f. Elektrochem.* 1902, v. 8, p. 659. Zellner: "New Progress in the Manufacture of Artificial Carbons"; *Elektrot. Zeitsch*, 1904, 24, Nov., p. 999. *Zeitsch., angew. Chem.*, 1904, 15, Apr., p. 498. "Factory Installation for Electrode-Carbons of the General Electric Co. at Birmingham," *Electrical Mag.*, 3, p. 382. "Installation of Gebr. Siemens & Co. at Charlottenburg." Wilke: "Handbook of Electricity." "The Manufacture of Carbon Electrodes for Electric Furnaces." Description of the Electrode Plant of the British Aluminum Co. at Kinlochleven (Scotland), and of Hoganas-Billesholm, Ltd. (Sweden). Report by Eugene Haanel of the Canadian Dept. of Mines on the "Working of Electric Stack Furnaces at Domnarfvet (Sweden)." *The Iron & Coal Trades Rev.*, 1909, 17, Sept., p. 430. "La Fabrication des Electrodes" par Isidore Bay, *La Houille Blanche* 7. no. 8, p. 169; no. 12, p. 251; no. 1, p. 20.

[10]In his English Patent No. 11010 of 1845, Church proposed to purify coke in such a way so that it could be brought to a high heat by a strong current. Castner: Engl. Pat. 19,809 (1893) *Zeitschrift fur Elektrochemie*, 1896, 1. Nov., p. 299. *Jahrb d. Elektrochemie*, 1895. v. 1, p. 251. Fitzgerald: "Artificial Graphite." p. 19. Process by Girard and Street, French Pat. 230,341 (1893), and 236,406 (1894); Eng. Pat. 13,340 (1893), No. 15,632 (1894), German Pat. 78,926 (1894), No. 85,335 (1895); *Zeitschrift f. Elektrochemie*, 1895, 1, Feb. p. 481; *Jahrb d. Elektrochemie*, 1895, I, p. 251. Street: "Electrical Furnaces and Their Use in the Conversion of Carbon into Graphite." Lecture before the Societe Internationale des Electriciens, *Bull.* Soc. El., v. 12, p. 246. *Elec.*, v. 35, p. 542; Becker: "Manuel d'Electrochimie," Paris, 1898, p. 447; Lefevre: *Genie Civil*, 1896, 20, June, p. 115; Borchers: "Electrochemistry at the Paris Exhibition," p. 91. *Zeitschrift f. Elektrochemie*, 1901, 4, Oct., p. 156, 244; 1903, 26, March, p. 261; *Elektrochemist*, 1901, p. 21; Fitzgerald: "Artificial Graphite," p. 20; Donat: "The Graphite," p. 139. Escard: "Le Carbone," p. 479. Borchers: "Electrical Furnaces," p. 114. Process was used by the Societe Anonyme le Carbone at Levallois-Perret, near Paris and at Notre Dame de Briaucon in the French Alps. Process by Acheson: U. S. Pat. 542,982 (1895) *Zeitschrift f. Elektroch.*, 1890, v. 2, p. 275; U. S. Pat. 568,323 (1896) *Zeitsch. d. Elektroch.*, 1896, v. 2, p. 206. See also Communications by Borchers: *Zeitsch. f. Electroch.*, 1895, 20, July, p. 167. U. S. Pat. 617,979 (1899); *Zeitsch. f. Elektroch.*, 1898, 21, July, p. 38. *Jahrb. d. Elektroch.*, 1900, v. 6, p. 298; see also communication by Borchers: *Zeitsch. f. Elektroch.*, 1897, 20, March, p. 394. Acheson: Lecture before the Franklin Institute on "The History, the Occurrence, the Use, the Known Methods of Production and the Theory of Graphite Formation." *Jour. Franklin Inst.*, 1899, June, p. 475. *Zeitsch. f. Elektroch.* 1898, Sept. 28, p. 218; *Jahrb. d. Elektrochemie*, 1900, v. 6, p. 294. See also communication by Borchers: *Zeitsch. f. Elektroch.*, 1897, 20, March, p. 394. U. S. Pat. 645,285, (1900). *Zeitsch. f. Elektroch.*, 1900, 7, June, p. 584. *Jahrb. d. Electroch.*, 1901, v. 7, p. 356. See also communication by Borchers: *Zeitsch. f. Elektroch.*, 1897, 20, March, p. 393-398: Donath: "The Graphite." Leipzig, 1904. Deuticke, p. 144-145; U. S. Pat. 709,758; German Pat. 133,592 (1900); "Conversion Into Graphite of Carbon-Electrodes"; *Zeitsch. f. Elektroch.*, 1903, 26, March, p. 262. *Jahrb. d. Elektroch.*, 1904, v. 9, p. 456. *Elec. World*, 1902, I, p. 1079; 1155; *Jour. Soc. Chem. Ind.*, 1902, 31, July, p. 979; *Elektroch. Zeitsch.*, 9, p. 223; Lond., *Elec.*, 50 p. 340. Donath: "The Graphite"; p. 156-157. Borchers: *Electrical Furnaces*, p. 54, 55; U. S. Pat. 711,031 (1902). *Jahrb. d. Elektroch.*, 1904, v. 9, p. 457; *Jour. Soc. Chem. Ind.* 1902, Nov. 15, p. 1336; *Elektroch. Ind.*, I, p. 130. The patents and processes of Acheson are treated jointly in Fitzgerald's book: "Artificial Graphite." Germ. transl. by Dr. Max Heeth, Halle, 1909; Knapp, p. 23 to 41.

Further shall be mentioned: The process by Wing, U. S. Pat. 598,549, (1898); *Zeitsch. f. Elektroch.*, 1898, 21, July, p. 38; *Jahrb. d. Elektroch.*, 1899, v. 5, p. 353. *Electrochemist & Metallurgist*, v. 2, 482; Donath: "The Graphite," p. 138. Process by Bergman, German Pat. 96,427, (1895). Process by Rudolphs and Harden, German Pat. 123,692, (1901); *Elektrotech. Zeitsch.*, 1901, 18, July, 584; *Jahrb. d. Elektroch.*, 1902, v. 8, p. 433; *Zeitsch. f. angew. Chemie*, 1901, 22, Oct., p. 1093. Process by Price, U. S. Pat. 752,357 and 752,356, (1904); *Jahrb. d. Elektroch.*, 1906, v. 11, p. 807. *Jour. Soc. Chem. Ind.*, 1904, 31, March, p. 326; *Electroch. Ind.*, 2 p. 111; Borchers: "Electrical Furnaces," p. 55. Process by Tone, U. S. Pat. 786,958 (1905); *Electrochemist & Metallurgist*, v. 2, p. 269. Borchers: "Electrical Furnaces," p. 56. *Elektrochemist*, 1901, p. 88. Haber: Report on "Electric Carbons" at the Paris Exhibition, 1900; *Zeitsch. f. angew. Chem.* 1901, 19, Feb., p. 184; *Jahrb. d. Elektroch.*, 1902, v. 8, p. 457. Chandler: "The Acheson Process"; lecture before the Am. Soc. of Chem. Ind., Extract in *Electrician*, 1901, p. 298; Townsend: "The Artificial Manufacture of Graphite"; *Elec. Wld. & Eng.*, v. 37, p. 546; *Zeitsch. f. Elektroch.*, 1901, 11, July, p. 776; *Jahrb. d. Elektroch.*, 1902, v. 6, p. 433; *Elekt. Anzeiger*, 1901, p. 1403. Fitzgerald: "Manufacture of Graphite After the Acheson Process"; *Jour. Soc. Chem. Ind.*, 1901, May 31, p. 444; *L'Ind.*

The Determination of Copper in Insecticides*

By George S. Jamieson

THE separation of copper as cuprous thiocyanate and its titration with a standard solution of potassium iodate in the presence of hydrochloric acid using an immiscible indicator such as chloroform as described by Jamieson, Levy, and Wells,[1] has been successfully applied to the estimation of copper in Bordeaux and Paris Green insecticides. When lead is present, it is necessary to remove it as the sulphate before proceeding to precipitate the copper. However, it has been found that arsenic did not interfere with the method.

The potassium iodate solution used in this investigation contained 11.7840 gr. of potassium iodate in 1000 cc. One cubic centimeter of this solution corresponded to 0.002000 gr. of copper. The reaction between the cuprous thiocyanate and the potassium iodate is represented by the following equations:

$$4CuSCN + 6KIO_3 + 8HCl = 4CuSO_4 + 2I_2 + 2ICl + 4HCN + 6KCl + 2H_2O$$

$$2I_2 + KIO_3 + 6HCl = KCl + 5ICl + 3H_2O.$$

From 0.2 to 0.5 gr. of insecticide, depending upon the amount of copper present, was weighed into a No. 2 beaker. The powder was thoroughly moistened with about 10 cc. of water. About 5 cc. of sulphuric acid (1:3) was added and the solution was warmed to facilitate the decomposition. It was observed in some cases that a small amount of difficultly soluble material remained even after heating. No attention need be paid to this, as it caused no interference with the accuracy of the method. When the sample was completely decomposed, the larger part of the free sulphuric acid was neutralized with (1:1) ammonium hydroxide.

The solution which should now have a volume of 30 to 40 cc. was heated almost to boiling and treated with 10 cc. of strong sulphur dioxide water. Then 5 to 10 cc. of a 10 per cent solution of ammonium or potassium thiocyanate was added and the solution was stirred for 2 minutes. The precipitate was allowed to settle for 15 minutes before filtration. The cuprous thiocyanate may be filtered either on a close filter paper or on asbestos in a Gooch crucible as preferred. The precipitate is washed with warm water until the soluble thiocyanate is removed. Owing to the slight solubility of the precipitate, care should be taken to avoid excessive washing.

Sometimes the cuprous thiocyanate will run through the filter. In such cases continue the filtration until the filter has become clogged and the filtrate is running clear, then refilter. No further trouble will be experienced.

The filter containing the precipitate is carefully removed from the funnel and folded so as to slip readily through the neck of the 250 cc. glass-stoppered bottle. Care should be taken not to occasion loss by allowing the fingers to come into contact with the precipitate. The precipitate adhering to the upper edge of the funnel or the Gooch crucible, the stirring rod, and the beaker is removed with small pieces of filter paper which are added to the titration bottle. A mixture of 35 cc. of concentrated hydrochloric acid and 20 cc. of water along with 7 cc. of chloroform are added. After each addition of potassium iodate solution, the stoppered bottle is thoroughly shaken. The rapidity with which the iodate solution may be added can be judged from the color changes of the aqueous solution and the chloroform. When the larger part of the iodine has disappeared, the titration should be continued carefully so as not to overtitrate the solution. The end point is the disappearance of the violet color from the chloroform. In order to prevent the hydrolysis of the iodine monochloride it is important to have a concentration of at least 10 per cent of hydrochloric acid in the solution at the end of the titration. According to the directions given above, enough hydrochloric acid is present so that 50 cc. of the iodate solution may be safely used without unduly lowering the acid concentration. For comparison the copper in the insecticides studied was determined by the thiosulphate method[2].

The following results were obtained:

Insecticide	Gr. Taken	Cc. of KIO_3 Used	Cu Found, Per Cent	Cu by Thiosulphate Per Cent
Paris Green No. 12,542	0.1447	17.60	24.27	24.33
Paris Green No. 12,542	0.1866	22.70	24.33	24.34
Paris Green No. 12,542	0.2389	29.00	24.27	24.31
Paris Green No. 12,542	0.4244	51.50	24.27	24.26
Paris Green No. 12,489	0.2667	32.55	24.41	24.45
Paris Green No. 12,489	0.2186	26.80	24.46	24.45
Paris Green No. 12,489	0.3012	36.80	24.44	...
Paris Green (*a*)	0.2038	24.20	23.75	23.79
Paris Green	0.3607	43.00	23.84	23.92
Paris Green	0.2775	32.95	23.75	23.82
Bordeaux Paris Green (*a*)	0.8089	76.00	18.79	18.76
	0.5121	48.18	1.881	18.80
Bordeaux Zinc (*b*)	0.4574	21.20	9.27	9.29
Arsenite	.....	.....	.....	9.26

(*a*) A. O. A. C. 1915 Referee Sample.
(*b*) A. O. A. C. 1916 Referee Sample.

These test analyses show that the iodate method gives very satisfactory results. In view of the advantages that this method has over the thiosulphate procedure[3] it can be highly recommended for the determination of copper in insecticides.

Bureau of Chemistry,
Washington, D. C.

A Georgetown, British Guiana, publication states that the Venezuelan Oil Concessions, Ltd., an English company, operating in Venezuela, has secured from the colonial office a large concession in the northwest district of British Guiana to explore for oil.

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[1] *J. Am. Chem. Soc.*, 30 (1908), 760, Treadwell-Hall, 3 ed., vol. II, p. 672.

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[2] *J. Assoc. Off. Agr. Chem.*, 2 (1916), No. 1, Part II, p. 12.

[3] *J. Am. Chem. Soc.*, 30 (1908) 760.

Ilsemannite*

Results of a Study of a Blue, Water-Soluble Molybdenum Compound Occurring in Utah—Methods of Analysis and Results of Extraction Tests

By H. F. YANCEY

A DEPOSIT of considerable size of a molybdenum ore partially soluble in water has been found recently near Ouray, Utah. The ore is a sandstone containing the blue mineral ilsemannite. About one-half of the molybdenum in the ore is soluble in water, giving a deep blue solution. The geological features of this deposit have been investigated by Frank L. Hess of the U. S. Geological Survey; while Waldemar T. Schaller, also of the Survey,[1] has presented a preliminary report on the mineralogical aspects of the mineral.

In the present paper, the results of a brief study of the water-soluble blue compound are given, together with some results obtained in extracting the molybdenum from the ore. As ilsemannite is a comparatively rare mineral, very little is found in the literature regarding methods of extraction.

The blue ore found near Ouray, Utah, first attracted attention because of its property of giving a very deep blue color to water. Samples submitted to various assayers by a development company brought the report that it was without value. Because of the intense blue color of the water-soluble portion of the ore, this company thought that the blue solution might possibly be used as a dye. The company submitted samples to a dye-house which reported that the ore contained "molybdenum blue," an artificial compound sometimes used as a dye, and that the specimens sent them were probably "faked," as "molybdenum blue" was unknown in nature.

Early Reports on Ilsemannite

Ilsemannite, a natural "molybdenum blue," was first reported as occurring at Bleiberg, Carinthia, by Hoefer in 1871,[2] who gave to it the name ilsemannite for J. C. Ilsemann (1727-1822), a German mining commissioner. It has also been reported by Lindgren and Ransome[3] as occurring in the Cripple Creek District, Colorado, and at Natal, South Africa, by duToit.[4] Horton[5] reports the occurrence of a molybdenum mineral having similar properties near Idaho Springs, Colorado.

The analysis of an air-dry sample from 90 pounds of the ore for the ordinary constituents gave the following results:

	Per Cent
Silica, SiO_2	65.92
Total iron as Fe_2O_3	4.35
Alumina, Al_2O_3	12.27
Titania, TiO_2	0.35
Lime, CaO	1.36
Magnesia, MgO	0.50
Molybdic Oxide, MoO_3	1.22
Total Sulphur as SO_3	11.09
Moisture	1.01
Loss on ignition	4.89

The material evolves hydrogen sulphide with dilute hydrochloric acid, and when heated in a closed tube it gives voluminous fumes of sulphur dioxide. Vanadium and lead are entirely absent, or present only in minute traces. Large pieces of the ore have a blue-gray color. A small amount of material resembling mica is present.

Constitution of Ilsemannite—Historical

The formula for ilsemannite generally given is $MoO_3.4MoO_3$. This formula was first given to a synthetic blue molybdenum compound by Berzelius. Hoefer[6] in naming a similar blue molybdenum mineral, ilsemannite, gave to it the formula of Berzelius, because the compound which was found in nature possessed similar properties. Various investigators have assigned different formulae to the synthetic molybdenum blue compound, but Guichard[7] in an exhaustive investigation has conclusively shown the formula to be $MoO_3.4MoO_3$ for the oxide anhydride, and the same formula with six molecules of water for the hydrate of the oxide. Several months after the publication of Guichard's paper, Bailhache[8] prepared two blue molybdenum molybdates by the interaction of the sulphate of the sesquioxide $Mo_2O_3.2SO_3$ with normal barium molybdate $BaMoO_4$, and with barium heptamolybdate $Ba_6Mo_7O_{24}$. The blue molybdates formed have the composition $Mo_2O_3.2MoO_3.6H_2O$, and $(Mo_2O_3)_3.(Mo_7O_{24})_2.18H_2O$ respectively. Bailhache also states that it is possible to obtain other blue molybdates by the action of each of the series of barium molybdates on "molybdyle" sulphate, $Mo_2O_3.2SO_3$. Guichard,[9] in a later paper, considers the method of preparation of the blue oxide by Bailhache and Klason[10] as interesting, but believes them to be identical with $MoO_3.4MoO_3.6H_2O$.

Very few workers have investigated the constitution of the blue molybdenum compound occurring in nature, the mineral ilsemannite. As previously stated, Hoefer named the mineral ilsemannite, and gave to it the formula of the synthetic molybdenum blue of Berzelius. Muthmann[11] did not accept the formula of Hoefer for the mineral, stating that ilsemannite is $MoO_3.2MoO_3$. Schaller[12], however, considers ilsemannite as a hydrous sulphate of molybdenum of the formula $MoO_3.SO_3.5H_2O$, and suggests that this "formula be taken until further quantitative analysis on pure material shows a difference." Schaller also states that the water-soluble portion of the ore contains iron sulphate, and that the consumption of permanganate in titrating this solution exactly equals

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[1] *J. Wash. Acad. Sci.*, 7, 417, 1917.

[2] *N. Jahrb. Miner.*, 566, 1871.

[3] *U. S. Geol. Survey*, Prof., Paper No. 54, 124, 1906.

[4] *So. African J. Sci.*, 13, 153, 1917.

[5] U. S. Bureau of Mines, *Bull.* 111, 15, 1916.

[6] Loc. cit.

[7] *Ann. Chim. Phys.* series 7, 23, 563, 1901.

[8] *Compt. Rend.* 133, 1210, 1901.

[9] *Compt. Rend.* 134, 173, 1902.

[10] *Ber. d. chem. G.*, 34, 148-158, 1901.

[11] *Liebig's Annalen*, vol. 238, 1887, p. 108.

[12] Loc. cit.

the amount of iron (as ferrous iron), determined gravimetrically, and also that the intense blue color of the water-soluble portion is due to an undeterminable trace of molybdenum dioxide, MoO_2.

Confirmation of a portion of Schaller's work, particularly with respect to the amount of molybdenum in the reduced condition, and to the presence of molybdenum sulphate, has been impossible. Instead of finding an undeterminable trace of molybdenum dioxide, a sample from the same deposit shows as much as 12.5 per cent of the total molybdenum present to be in the reduced condition, assuming it to be present as molybdenum dioxide (MoO_2). Schaller considers ilsemannite to be a hydrous sulphate of molybdenum, basing his formula on incomplete analysis of the water-soluble portion of the ore. It has been found that a somewhat more complete analysis of the water-soluble portion of the ore does not show the presence of sufficient sulphuric anhydride to combine with any of the molybdenum if the iron, aluminium, calcium and magnesium are assumed to be present as sulphates.

Schaller considers the intense blue color of the water-soluble portion of the ore to be due to an undeterminable trace of MoO_2, which he considers as having a very high coloring power. Ullik[13] in 1867 prepared impure molybdenum dioxide having a blue color in the crystalline form. The pure oxide according to later investigators is not blue, but brown or violet brown.[14] Muthmann[15] obtained pure molybdenum dioxide in opaque crystals having a violet reflex which were insoluble in boiling hydrochloric acid and caustic potash. It is, therefore, improbable that molybdenum dioxide is itself soluble in water, and that the blue color of the water-soluble portion of the ore is due to molybdenum dioxide alone. However, molybdenum dioxide is blue when in combination with the trioxide in the form of a double oxide or molybdenum molybdate; but the presence of only a trace of a lower oxide in combination with its equivalent of the trioxide is not enough to account for the blue color of the water extract of the ore.

Determination of Reduced Molybdenum

The selection of a method for determining the quantity of molybdenum in the reduced condition in the water-soluble portion of the ore presented many difficulties. This is true because the water extract contains ferrous iron as well as reduced molybdenum. The blue molybdenum compound present is easily oxidized by the ordinary oxidizing agents. A reagent which would oxidize the iron without oxidizing the molybdenum could not be found. A solution of ferric iron oxidized the reduced molybdenum, and was most promising, but the reaction did not apparently proceed to completion until the addition of a considerable excess of ferric iron. Again, the oxidation of the reduced molybdenum by ferric iron is somewhat slow. It was then considered advisable to find a method of separating the iron in the water extract of the ore from the blue molybdenum compound. Ninety-five per cent alcohol dissolved the blue material of the ore, but at the same time also dissolved the ferrous iron. Absolute alcohol was next tried, but this would dissolve only a very small amount of the blue compound and some ferrous iron. Guichard[16] states that molybdenum molybdate $MoO_2.4MoO_3$ is soluble in alcohol, but not in ether. He also says that below certain concentrations, sulphuric and hydrochloric acids diminish the solubility of the blue double oxide in water without altering its composition. Diethyl ether did not extract the blue compound from the ore, nor from the blue water-soluble portion of the ore. However, when sulphuric or hydrochloric acid was added to the blue water solution, the solubility of the blue compound was diminished, and the blue color of the water layer was partially transferred to the ether layer on shaking. Under certain conditions to be described later, and by washing the ether extract with dilute hydrochloric acid, it is possible to completely remove the iron from the blue compound which remains dissolved in the ether. The ether may then be evaporated and the reduced as well as the total molybdenum determined.

The method used to determine the reduced molybdenum in the ether extract was to allow the ether to evaporate at room temperature until nearly all had evaporated. The remainder was then evaporated rapidly *in vacuo*, the process being continued for a time in order to remove all hydrochloric acid. The blue compound was then dissolved in water, filtered, and titrated with hundreth-normal permanganate, 5 cc. of 1:1 sulphuric acid being added to the blue water solution. The reduced molybdenum was calculated as MoO_2. A negative correction for a blank determination was applied to the titration in the following manner: Hydrochloric acid and ether of the same volumes as used in the extraction were shaken together, separated, the ether evaporated and titrated with permanganate. The total molybdenum in the same solution was determined by evaporating the solution to fumes with sulphuric acid, diluting with water, and then adding an excess of sodium hydroxide solution. The precipitate of manganese hydroxide is filtered off, and examined for traces of iron. It is not usually necessary to make a reprecipitation at this point. The filtrate is acidified with sulphuric acid, about 2½ per cent excess acid being added, and the molybdenum determined by passing the hot filtrate through the Jones reductor, according to the method of Randall.[17]

Extraction of the Blue Compound with Ether

Two hundred grams of ore was extracted successively with small portions of hot water until the volume of the filtrate was 500 cc. Most of the water-soluble blue material was removed by this treatment. An aliquot of 200 cc. was transferred to a separatory funnel, and 50 cc. of hydrochloric acid (conc.) added. The mixture was then cooled under the water tap, and 200 cc. of ether added. This was shaken vigorously, and cooled during the shaking. The layers of ether and water were then allowed to separate, and the water layer drawn off into another separatory funnel, and again extracted with 100 cc. of ether. After separation of the two layers, the ether extracts were combined, and washed ten times with 10 cc. of concentrated hydrochloric acid diluted to 25 cc. with water. Acid of this concentration dissolves but a very small portion of the blue compound originally extracted by the ether. The acid washings were tested for iron, and the process discontinued when

[13] *Liebig's Annalen*, 144, 227, 1867.
[14] Guichard, *Compt. Rend.*, 129, 722, 1899.
[15] *Liebig's Annalen*, 238, 114, 1887.
[16] Loc. cit.
[17] *Amer. Jour. Sci.*, 24, 313, 1907.

all was removed. After the washing was complete, the ether extract was allowed to stand for about two hours to complete the separation of suspended dilute acid. This was then drawn off, and the reduced and total molybdenum determined.

The extraction process as outlined does not remove all of the blue compound from the water solution. This may be accomplished by increasing the concentration of hydrochloric acid, and then extracting about three times more with 100 cc. portions of ether. However, if all the blue compound is extracted, it will be found impossible to wash all of the iron out of the ether extract, and ferric iron will be formed. The ferric iron will oxidize some of the reduced molybdenum, and the per cent of molybdenum in the reduced condition will be lowered.

It was found that when the blue material was totally extracted by ether from the water layer that all of the molybdenum was at the same time removed. This would indicate that the blue material is a compound, and, therefore, of definite composition. It at least possesses the property of being completely soluble in ether saturated with hydrochloric acid. All attempts to show definiteness of composition by extracting a given aliquot in two stages, and determining the per cent reduced molybdenum in each extract failed, because it was impossible to remove the iron from the second and complete extraction of the blue color from the water.

Numerous determinations showed that the blue material extracted by ether contained from 11.5 to 12.5 per cent reduced molybdenum, assuming the reduced molybdenum to be present as molybdenum dioxide (MoO_2). This amount of reduced molybdenum accounts for 50 per cent of the water-soluble blue compound, which is extracted by ether if it be present in the heretofore accepted form of molybdenum molybdate ($MoO_2.4MoO_3$). The blue material extracted by ether, after removal of iron, does not give a test for sulphates. As about one-half of the blue compound, from a given volume of water extract, may be removed by ether, then at least one-half of the water-soluble molybdenum may be obtained free of sulphates. The only reason that all of the water-soluble molybdenum may not be obtained free of sulphates is because the ether extract cannot be washed free of iron sulphate if all of the "molybdenum blue" is removed from the aqueous layer.

Direct Titration

In view of the results just given, and their marked difference from those obtained by Schaller,[11] it was considered advisable to determine the amount of reduced molybdenum in the water-soluble portion of the ore by the direct titration of the water solution. Schaller found that direct titration of this solution with permanganate exactly equals the amount of iron (as ferrous iron) determined gravimetrically.

Determination of reduced molybdenum in the water solution by direct titration with permanganate, and then the determination of total iron and total molybdenum, and calculation of the amount of reduced molybdenum from the difference between the iron and the direct titrations involves the assumption of the absence of ferric iron. Tests for ferric iron on freshly prepared water extracts of the ore with molar ammonium thiocyanate solution were negative. If one milligram of ferric iron in 1 cc. of water be added to 9 cc. of the blue solution, and a few drops of thiocyanate solution be added quickly, the characteristic red coloration is produced. As soon as the ferric iron solution is added to the blue solution, the blue color becomes less intense, due to the oxidation of the blue compound. However, the rapid addition of thiocyanate suffices to detect the presence of that portion of the original milligram of ferric iron remaining unreduced. If the thiocyanate is not added quickly, the iron added is reduced, and does not give the red coloration.

Tests on the water-soluble portion of the ore for sulphur dioxide and hydrogen sulphide were negative. As ferric iron is also absent, the direct titration method as outlined should give an accurate determination of the amount of reduced molybdenum.

By quickly preparing and titrating the water-soluble material from 200 grams of the ore in five equal aliquots with standardized permanganate solution, 12 per cent of the total molybdenum present was found to be in the reduced condition. This figure agrees very well with the amount of reduced molybdenum determined by the ether extraction method. The iron in the same aliquots was determined by reducing with zinc (reductor), and titrating with the same solution of permanganate. The total molybdenum was determined in the filtrate from the iron (two precipitations) by the method already given.

Analysis of Water-Soluble Material

A quantity of ore (250 grams) sufficient to approximately saturate 100 cc. of water was boiled with the water for about twenty minutes. This was then filtered, washed with 50 cc. of cold water, and evaporated to dryness. The dark blue solid was dried at 105 deg. C., and examined quantitatively for the ordinary radicals with the following results:

	Per Cent
Silica, (SiO_2)	0.98
Alumina, (Al_2O_3)	10.62
Ferrous oxide, (FeO)	9.58
Titania, (TiO_2)	trace
Calcium oxide, (CaO)	1.24
Magnesium oxide, (MgO)	1.36
Sulphur trioxide, (SO_3)	28.48
Molybdic oxide, (MoO_3)	23.85
Chlorine, (Cl)	0.17

This is not a complete analysis. The sample analyzed contained 1.10 per cent moisture, as determined by drying at 150 deg. C. for one hour. The loss on ignition was 43.8 per cent, but this represents a loss of molybdenum, and possibly water of hydration.

If all of the iron oxide, alumina, lime and magnesia are present as sulphates, one gram of the material would require 0.4010 grams of sulphur trioxide. One gram would contain only 0.3848 grams of sulphur trioxide. However, some silica and a small amount of chlorine are present. On this basis the 23.85 per cent molybdic oxide (total Mo calculated as MoO_3) could not be in the form of a sulphate. Schaller proposed his sulphate formula for ilsemannite without determining alumina, lime and magnesia if present in the sample examined by him.

Miscellaneous Properties of the Blue Solution

Qualitative ionic migration experiments on the water-soluble portion of the ore showed that the blue color behaved as a cation. With a current of 80 milliamperes,

[11] Loc. cit.

the movement toward the negative electrode is apparent after about 30 minutes. Other carriers, however, were present in the agar-agar blue layer besides the blue compound, as the blue water extract of the ore was used in making up the tube. With a small amount of hydrochloric acid present in the blue layer, a similar effect was noted. The results would seem to indicate that the cation of the blue compound is also blue, and that probably the MoO_2 ion is acting as the positive carrier, though the effect may denote colloidal migration. Guichard[19] states that the molybdate of the dioxide of molybdenum ($MoO_2.4MoO_3.6H_2O$) is a colloid. In this connection, it is interesting to note that the similar divalent compound of uranium, the uranyl radical (UO_2) has decidedly basic properties, and that on electrolysis of its salts the uranyl (UO_2) ion migrates to the cathode.[20] Among the members of Group VI of the periodic classification, which included molybdenum, the dioxides $R^{VI}O_2$ of the members of low atomic weights, sulphur, selenium and tellurium are acidic or neutral. As the atomic weight of the elements increase, the basicity of the radical $R^{VI}O_2$ also increases, and the compounds formed become more stable. Brownish violet molybdenum dioxide (MoO_2) united with white or yellow molybdic oxide (MoO_3) to form blue molybdenum molybdate ($MoO_2.4MoO_3$); brown tungsten dioxide (WO_2) interacts with yellow tungstic oxide (WO_3) to form blue and purple-red tungsten tungstates; while brown uranium dioxide (UO_2) and brownish-red uranic oxide (UO_3) form green and black uranium uranates.

Guichard[21] prepared molybdenum dioxide by electrolysis of molten molybdic oxide, and Junius[22] has obtained blue molybdenum molybdate of the formula Mo_7O_{20}, at the cathode by the electrolysis of molybdic oxide in strong hydrochloric acid.

One-half gram of ammonium molybdate was evaporated nearly to dryness with sulphuric acid. After standing some time, the characteristic molybdenum blue color developed. Extraction of the blue color with ether in the presence of hydrochloric acid showed that only 8 per cent of the molybdenum had been converted into the blue compound. The remaining molybdenum sulphate was not nearly so soluble in ether as the blue of ilsemannite. If the blue of ilsemannite is molybdenum sulphate, then it should not be entirely soluble in ether saturated with hydrochloric acid. However, as pointed out under the section "Extraction of the Blue Compound with Ether," it is entirely extracted by ether.

The blue water extract makes an excellent ink, though it is slowly oxidized in the air. The blue color of the writing is discharged by hydrogen peroxide, but reappears if moistened with stannous chloride solution. Sulphur dioxide does not produce analogous results.

Conclusions

The above work does not constitute a basis for the proposal of a formula for ilsemannite. The formula proposed by Schaller[23] ($MoO_2.SO_3.3H_2O$) is not supported by the present investigation. Muthmann's[24] formula ($MoO_2.2MoO_3$) more nearly fits the properties of the compound as determined, but requires perhaps too much reduced molybdenum. Guichard[25] has shown the formula of Muthmann for the synthetic blue oxide ($MoO_2.2MoO_3.xH_2O$) to be inaccurate; that it really is $MoO_2.4MoO_3.6H_2O$. But even Guichard's formula does not fit the blue of ilsemannite completely; as the water-soluble portion of the molybdenum in the ore does not contain sufficient reduced molybdenum. However, it is preferable for the present to consider the ore examined as a mixture containing the original parent molybdenum mineral, and water-soluble ilsemannite of Guichard's formula together with other water-soluble oxides of molybdenum formed in the alteration process.

Extraction of Molybdenum from the Ore

The methods employed in treating the ore are divided into four general classes: Extraction with water, extraction with dilute acids, with dilute alkali carbonates and alkalies, and by roasting with a small amount of various reagents followed by a water leach. Obviously fusion methods, such as are being used on wulfenite concentrates, would not be commercially applicable to a one per cent molybdenum ore.

It is not intended to convey the impression that all or any of the methods given could be used profitably in extracting molybdenum from the ore. A problem of this nature, of necessity, depends on many conditions outside of the laboratory. It is hoped that suggestions given here may be of some use if other conditions warrant the development of this deposit of ilsemannite.

Unless otherwise noted, the ore used in the following experiments was of the following size: Thirty-five per cent is retained on 40 mesh screen; 35 per cent passes 40 mesh, but is retained on 80 mesh, and 30 per cent passes 80 mesh.

Leaching Experiments with Water and Acids

The plan followed in determining the per cent of molybdenum that could be extracted by water was as follows: A sample of the ore (10 grams or more) was treated with successive portions of water, until the filtrate from the water leach showed little or no blue color. The water solution was then oxidized with nitric acid, the blue color disappearing, taken to fumes with sulphuric acid, diluted, and made alkaline with sodium hydroxide. The precipitate was filtered off, the filtrate made acid with sulphuric acid, heated to about 70 deg. C., and passed through the Jones reductor into a solution of ferric ammonium sulphate decolorized with a few cc. of syrupy phosphoric acid. This was then titrated with standard potassium permanganate to a one-half-minute pink. In order to determine the solubility of the ore in a large excess of water, one gram was leached with 150 cc. of hot water. The residue was dried at 105 deg. C.; 4.34 per cent of the ore was found to be soluble. The residue contained a little less than 15 per cent molybdic oxide.

If 10 grams of ore is treated with three successive portions of hot water of 30 cc. each, coming to a boil each time, between 46 and 54 per cent of the molybdenum in the ore is removed. These results have been confirmed by numerous trials.

In order to determine the quantity of ore required to give the highest concentration of molybdenum in a given

[19] Loc. cit.
[20] Roscoe and Schorlemmer II, 1108, 1913.
[21] *Am. Chim. Phys.* series 7, 23, 563, 1901.
[22] *Zeit. Anorg. Chem.*, 46, 428, 1905.
[23] Loc. cit.
[24] Loc. cit.
[25] Loc. cit.

volume of water, separate portions of 5, 10, 15, 20 and 25 grams of the coarser mesh ore were treated with 10 cc. of water each. The water was allowed to come to the boiling point, when the entire contents of each beaker were placed on separate filters. The residues on the paper were then washed with 10 cc. of cold water, and the molybdenum content of the filtrates determined. The results are given below:

Grams of ore	5	10	15	20	25
Cubic centimeters of $KMnO_4$	17	27	34	36	38
Per cent Mo extracted	46	40	33	28	23

These results show that saturation has not been quite reached, but that approximately one part of water requires from two and one-half to three parts of the ore. The cc. of $KMnO_4$ used in the data tabulated above refers to molybdenum present in the water-solution. One cc. $KMnO_4$ is equivalent to 0.00132 grams Mo; per cent Mo extracted means the per cent of the total present extracted.

Extraction of the Ore with Cold Water

Twenty-five grams of the ore, and 10 cc. of water at room temperature were allowed to stand for one hour. The solution was then filtered off, and the Mo in the filtrate determined. The residue was leached one hour with another 10-cc. portion of cold water, filtered, and the Mo determined. This operation was repeated four times in all. The result are as follows:

Extraction No.	1	2	3	4	Total per cent of Mo extracted
Per cent Mo extracted	12	15	4	2.5	33.5

To determine whether a finer mesh would permit the extraction of a larger per cent of the molybdenum, a portion of the sample above mentioned was ground to pass 150 mesh. This was then extracted with hot water along with a sample of the coarser material. After three hot water leaches of 30 cc. each, the residues were extracted with 50 cc. of hot 15 per cent sulphuric acid. The results are given below:

	Coarse mesh	150 mesh
Per cent extraction Mo hot water	54	57
Additional per cent extraction Mo in hot 15% sulphuric acid	16	27
Total extraction water and acid	70	84

It will be noted that fineness of the ore does not materially increase the percentage extraction in the case of water, but that it does increase it if the water leach is followed by sulphuric acid. Perhaps with additional acid leaches all of the molybdenum might be extracted. Ten grams of ore leached successively with three 30 cc. portions of hot water followed by 50 cc. of 1:1 ammonium hydroxide gave an extraction of 63 per cent; while the same weight of ore leached with two 50 cc. portions of 1:1 ammonium hydroxide gave only a 39 per cent extraction.

Comparative Results on Leaching with Water and Acids

Additional leaching experiments with water and acids on both the coarse-mesh ore and the 150-mesh ore gave results as indicated in Table I; in each case 10 grams of ilsemannite and boiling reagents were used.

The best results are given by 5 per cent sulphuric acid. It will be observed that the finer mesh ore gives much better yields with all acids; also that in most instances a preliminary treatment with water followed by acid gives a somewhat better yield than the reverse treatment. It is improbable, however, that a process involving the use of 150-mesh ore could be used commercially. It was also determined that reduction of the sulphuric acid concentration much below 5 per cent gives such a poor extraction as to render it useless.

TABLE I—LEACHING EXPERIMENTS

Treatment of Ore	Per Cent Mo Extracted
No. 1. Coarse mesh ore leached with two 30-cc. portions of boiling water, followed by 50 cc. of 5% boiling H_2SO_4, then 10 cc. of cold water	67
No. 2. 150-mesh ore, same treatment as above	80
No. 3. Coarse ore leached with 50 cc. boiling 5% H_2SO_4, then two 30 cc. boiling water, then 10 cc. cold water	68
No. 4. 150-mesh ore, same treatment as coarse ore above	83
No. 5. Coarse ore, two 30 cc. water, then 20 cc. 15% H_2SO_4, 10 cc. cold water	64
No. 6. 150 mesh ore, treated as No. 5	79
No. 7. Coarse ore, 20 cc. 15% H_2SO_4, then two 30 cc. water followed by 10 cc. cold water	62
No. 8. 150-mesh ore, same as No. 7	76
No. 9. Coarse ore, two 20 cc. water, 20 cc. 5% HCl, 10 cc. cold water	64
No. 10. 150-mesh ore, same as No. 9	80
No. 11. Coarse ore, 20 cc. 5% HCl, two 20 cc. water, then 10 cc. cold water	61
No. 12. 150-mesh, same as No. 11	83
No. 13. Coarse ore, two 20 cc. water, 20 cc. 2% HNO_3, 10 cc. cold water	70
No. 14. 150-mesh ore, same as No. 13	79
No. 15. Coarse ore, 20 cc. 2% HNO_3, two 30 cc. water, 10 cc. cold water	70
No. 16. 150-mesh, same as No. 15	77

Leaching Experiment with Aqueous Caustic Soda and Sodium Carbonate

Ten grams of the ore with 0.25 grams of sodium carbonate and 50 cc. of water were heated to boiling, and the soluble material then filtered off. The residue in the beaker was washed by decantation with two 25-cc. portions of boiling water. The molybdenum in the aqueous extract was then determined, and the per cent of the total present that had been removed computed. This experiment was then repeated, using sodium hydroxide instead of sodium carbonate, exactly the same amount as those given above being used.

	Na_2CO_3	NaOH
Per cent Mo Extracted	60 to 66	78 to 82

The color of the sodium carbonate extract was blue, but that of the sodium hydroxide extract was brown to yellow, filtering with more difficulty than the carbonate. The ratio of the weight of reagent to that of the ore is equivalent to 50 pounds of reagent per ten of ore. Using 25 pounds of sodium hydroxide per ton of ore in exactly the same manner as the above, an extraction of 67 per cent was obtained.

An experiment on a larger scale using 50 pounds of minus 30-mesh ore and 1.25 pounds of sodium hydroxide in 200 pounds of water gave an extraction of 72 per cent of the molybdenum, calculated on the basis of the heads and tails.

In addition to the wet methods used above, the ore was roasted with various reagents at a temperature below 600 deg. C. Sodium chloride, sodium nitrate, sodium pyrosulphate and charcoal were tried alone, and in mixtures of one part of reagent or mixtures of reagents to ten parts of ore. The sintered cake resulting was then extracted with hot water. In no case was the extraction improved over that of hot water alone. The extraction of molybdenum varied from 16 to 28 per cent.

I desire to express my thanks to Dr. R. B. Moore, under whose direction the above work was carried out, and to Dr. S. C. Lind for a number of helpful suggestions.

U. S. Bureau of Mines,
Golden, Colorado.

The Metallography and Heat Treatment of Metals Used in Aëroplane Construction—II

Investigation of Parts Made From Medium-Carbon, High-Carbon and Chrome-Nickel Steels—Causes of Failure in Cam Wheels, Piston Pins and Crank Shafts

BY F. GROTTS
Chief Metallurgist, Curtiss Aëroplane and Motor Corporation

MEDIUM-CARBON STEEL

THIS steel is called forging stock and from it are made propeller hubs, wing plates, strut sockets, hinges, both male and female, bolts, etc. Average chemical analysis: Carbon 0.35, manganese 0.65, sulphur 0.04, and phosphorus 0.032 per cent.

The raw stock has the following physical properties:

Ultimate strength, lb.	80,800
Yield point, lb.	54,600
Elongation, per cent.	33
Reduction, per cent.	62
Brinell	153
Scleroscope	30

Heat treatment of 1550 deg. quenched in oil and drawing at 965 deg.

Ultimate strength, lb.	96,000
Yield point, lb.	68,000
Elongation, per cent.	22
Reduction, per cent.	68
Brinell	194
Scleroscope	36

The principal defects found in this type of steel are pipes and slag inclusions. The pipe shown in Fig. 32 was heated at a temperature of 1600 deg. for one hour and a half in an attempt to improve it. There was no marked change. Material of this type will grow worse or the pipe will grow on usage. This illustration is of interest because it is thought by some that heat treatment will do away with pipes.

This material has given less trouble than any other as it responds very nicely to heat treatment, i.e., gives the necessary physical properties, and there have been few rejections from slag, pipes, excess phosphorus or sulphur.

On several occasions this stock has been mixed with nickel steel. The separation was brought about by taking a small section from each rod and quenching all at a temperature of 1500 deg. and scleroscoping. The nickel scleroscoped about 60, and the carbon steel 40.

One or two illustrations were found of a brittleness that was probably caused by the pickling operation. The reaction of the acid on the steel gave off hydrogen which was absorbed and gave rise to the defect. Concentrated caustic solutions at a boiling temperature used for removing the quenching oils also gave a slight attack, as in the case of the pickling.

Some tests have shown a variance in crystal size. This depends on many factors, principal of which are the temperature of the steel prior to rolling, the deformation during rolling, the finishing temperature, and the rate of cooling.

Owing to the many variables it is difficult to arrive at any accurate method of calculating the strength of a steel of this type from the chemical analysis. The following data give a fairly good approximation.

Carbon—In acid steel each 0.01 per cent carbon strengthens the steel by 1000 lb. per square inch. In basic steel each 0.01 per cent strengthens the steel by about 700 lb. per square inch.

Phosphorus—Each 0.01 per cent strengthens the steel by about 1000 lb. per square inch.

Manganese—In acid steel each 0.01 per cent above 0.4, about 200 lb. per square inch. *Basic steel*, about 90 lb. per square inch.

The strength derived from manganese increases as the carbon content decreases.

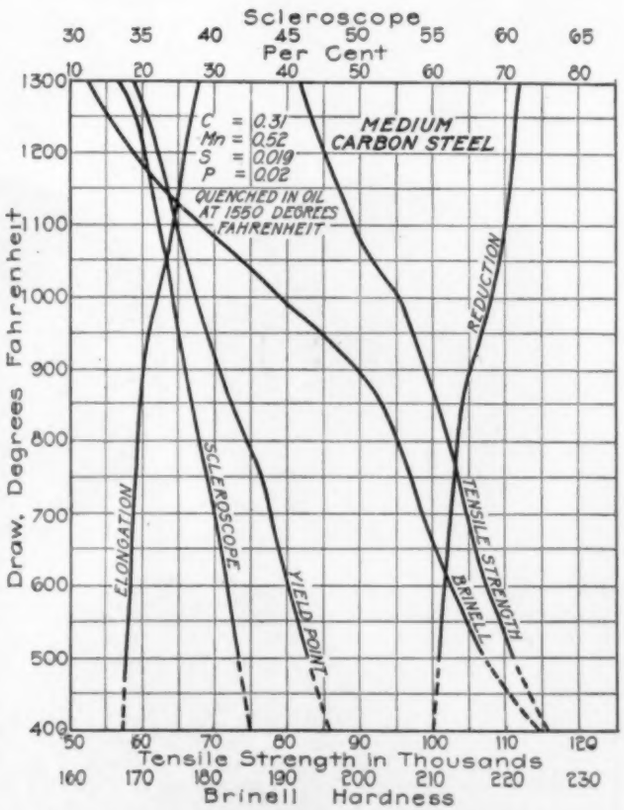


PLATE 2.—PROPERTIES OF MEDIUM CARBON STEEL

Sulphur—Practically has no strengthening effect. Formula—Acid Steel:

40,000 + 1000C + 1000P + 200Mn = Raw stock.

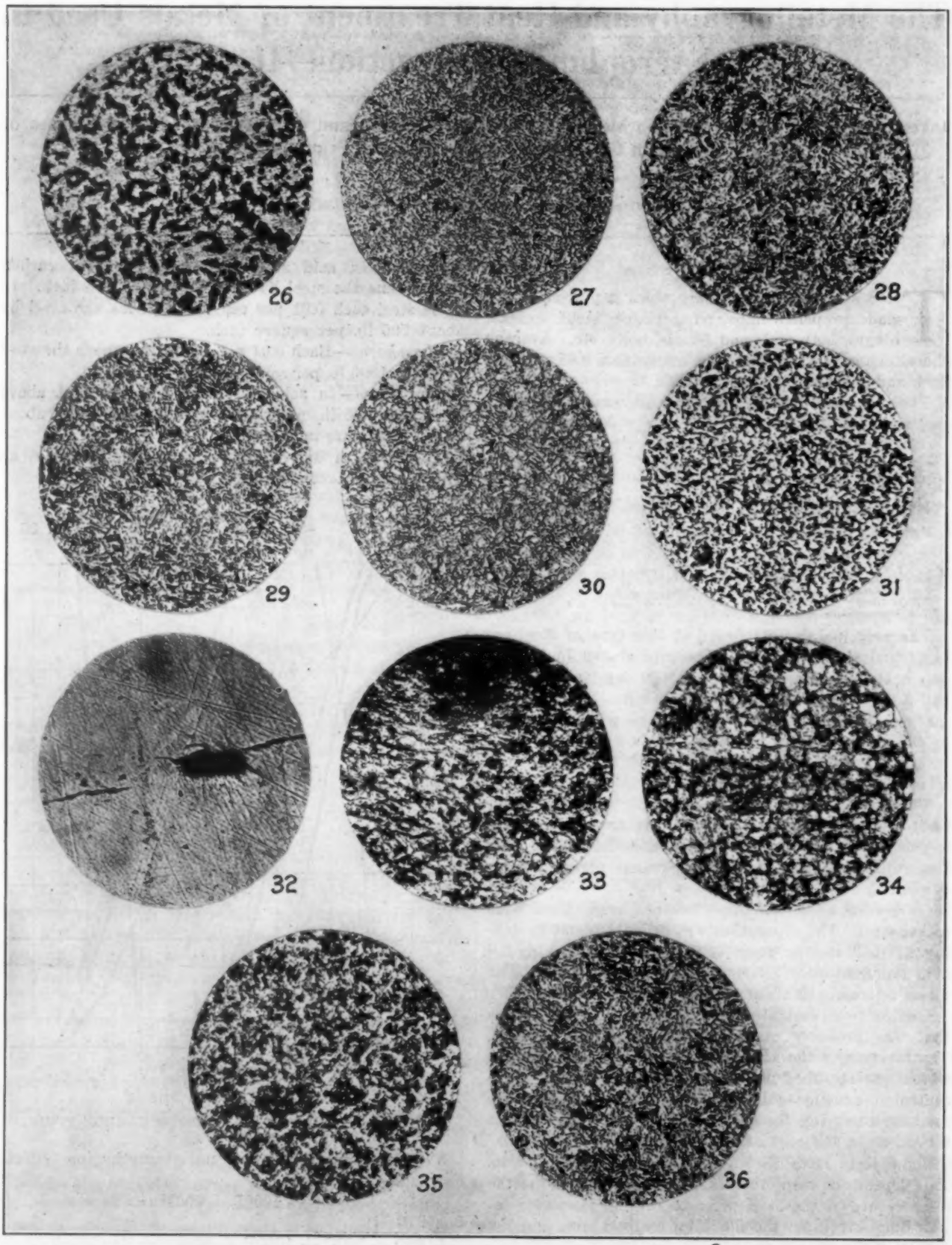
Basic Steel:

42,000 + 700C + 1000P + 90Mn = Raw stock.

Raw stock + 33⅓ per cent = Quenched stock.

Quenched stock — 2000 lb. for each 100 deg. draw.

A cam wheel on showing peculiar properties (softness, distortion) after being used was investigated to



FIGS. 26-36

Figs. 26-31—Medium Carbon Steel. Analysis: C, 0.35 per cent; Mn, 0.65; P, 0.04; S, 0.032. Etched with picric acid: x 100. Fig. 26—annealed; 27—quenched; 28—quenched and drawn at 800 deg.; 29—quenched and drawn at 1000 deg.; 30—quenched and drawn at 1200 deg.; 31—raw stock. Fig. 32—Pipe in medium carbon steel. Fig. 33—Section taken through cam on wheel. Fig. 34—Section of wheel some distance from cam, showing general structure. Fig. 35—Control lever before quenching and drawing. Etched with picric acid; x 100. Fig. 36—Control lever properly treated.

determine the cause of said properties. This material was supposed to be medium carbon steel cyanided at 1600 degrees for ten minutes and quenched in water.

The wheel was first scleroscoped carefully, then sections were taken and quenched and again scleroscoped. Near the cam a section was taken; then one some distance away. These were polished, etched with picric acid and photographed at a magnification of 100. The photomicrographs are shown in Figs. 33 and 34. The scleroscope test of the wheel, as received, gave 27; after quenching in water at 1475 deg., 29; quenching at 1550 deg., 31. A chemical analysis gave the following results: C, 0.09 per cent; Mn, 0.37; S, 0.101; P, 0.112; Fe, 98.

Summary—The material is very poor and has been slightly case-hardened on the bearing or concave surface.

Fig. 34 shows that it is very low carbon stock with a very poor structure as one would expect from screw stock (high S and P).

Fig. 33 taken from the cam shows where the material is distorted by usage; also slightly carbonized. It would be impossible to handle such material in any way to get satisfactory results.

An excellent material for this part is chrome-nickel steel. By heat-treating it will give all of the necessary properties and will be superior to any carbon steel.

Control Lever Investigation

This lever on being placed in the machine bent and was too soft for service. It was supposed to have been made of medium carbon steel (0.32 per cent) and quenched at 1550 deg. in oil and drawn at 1000 deg.

The object of the investigation was to determine if possible the explanation of the objectionable properties. A chemical analysis showed C, 0.31 per cent; Mn, 0.55; S, 0.046 and P, 0.023.

Scleroscope 28 and Brinell 145.

A section was taken, polished, etched with picric acid and photographed at a magnification of 100. This section was then taken, quenched at 1550 deg. and drawn at 1000 deg. This was also photographed.

Fig. 35 shows the lever as it was and Fig. 36 shows it properly treated.

Summary—The lever had been annealed (Fig. 35) and left in that condition. A proper heat treatment of about 1550 deg. quench in oil and draw at 1000 deg. would have shown a scleroscope hardness of 35 to 40 and a Brinell of 195 to 210. Fig. 36 shows the structure of the material properly handled.

It is well at this point to take into consideration the use of the scleroscope. This is a very valuable piece of apparatus in connection with heat-treating. It is recommended that the material be scleroscoped before and after heat treating.

Precautions in using:

1. Instrument should be mounted on a firm base in good light.
2. A good smooth surface with a fine file are necessary.
3. Round specimens should be tested on the end and not the curved surface.
4. Take the mean of several readings.
5. Do not take two readings in the same place—shift the apparatus.

High-Carbon Steel

Tail-skid shoes, cable wire, and some springs are made from high-carbon steel. There is considerable trouble in heat-treating this steel as it will crack when quenched cold. It is preferable to heat to the quenching temperature (1450 deg.) and after quenching remove from the oil before cold or while it has a temperature of probably 200 deg. This will give a slight drawback and will relieve any strains. Hot water has been used with good results on this material. Oil gives a better and tougher result than can be obtained from any other quenching medium.

The chemical analysis of this stock is 0.93 per cent C, 0.35 Mn, 0.016 S, and 0.035 P. By lowering the carbon to about 0.55 and increasing the manganese to 0.85 there will result as good a material if not better for shock-resisting properties.

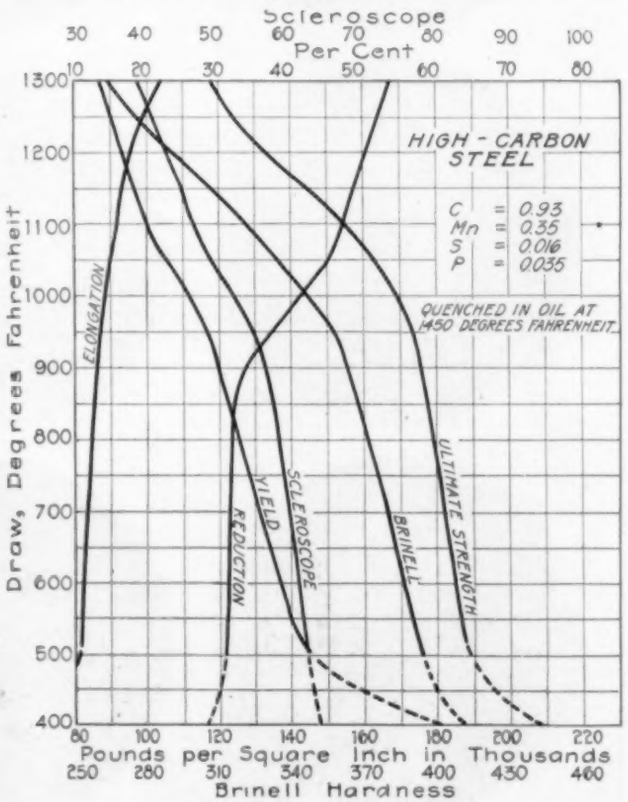


PLATE 3.—PROPERTIES OF HIGH CARBON STEEL

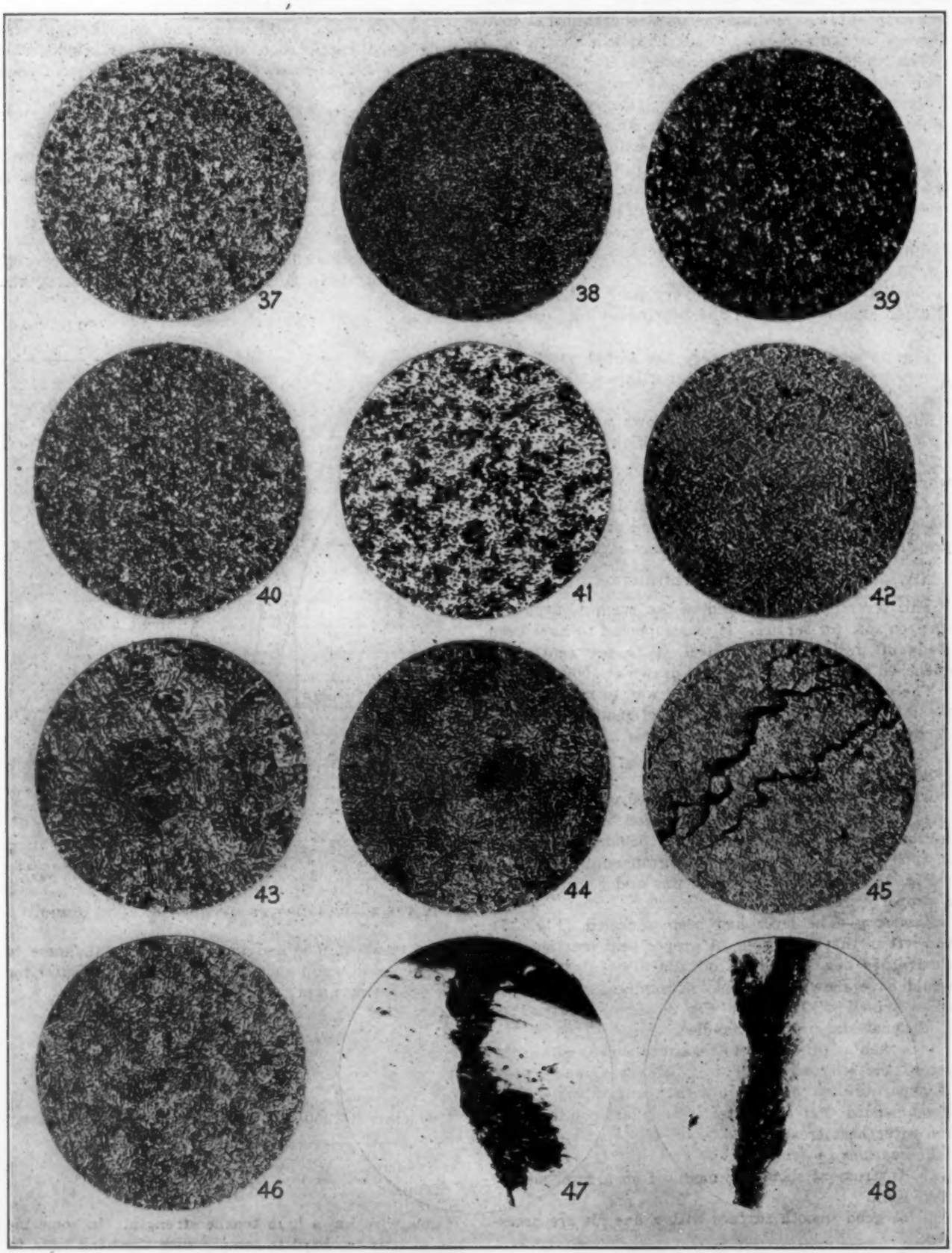
Raw stock physical properties:

Ultimate strength, lb.	113,000
Yield, lb.	72,200
Reduction, per cent	38
Elongation, per cent	20
Brinell	223
Scleroscope	38

Quenched at 1450 deg. in oil and drawn at 650 deg.:

Ultimate strength, lb.	184,000
Yield, lb.	132,000
Reduction, per cent	33
Elongation, per cent	11
Brinell	385
Scleroscope	60

Cable wire has a high tensile strength. In some instances it is too hard to comply with the bend tests in which case it is slightly drawn at from 450 to 600 deg. Much of this material has been rejected because of fine cracks which were probably caused from trying to obtain a too high tensile strength by straining in cold drawing.



FIGS. 37-48

Figs. 37-40—High Carbon Steel. Analysis: C, 0.93 per cent; Mn, 0.35; S, 0.016; P, 0.035. Etched with picric acid; x 100. Fig. 37—quenched; 38—quenched and drawn at 800 deg.; 39—quenched and drawn at 1000 deg.; 40—quenched and drawn at 1200 deg. Figs. 41-44—Chrome Nickel Steel. Analysis: C, 0.30 per cent; Si, 0.19; Mn, 0.51; S, 0.029; P, 0.042; Cr, 0.61; Ni, 1.79. Etched with picric acid; x 100. Fig. 41—raw stock; 42—quenched; 43—quenched and drawn at 1000 deg.; 44—quenched and drawn at 1200 deg. Fig. 45—Hardening cracks in piston pin. Etched with picric acid; x 100. Fig. 46—Sorbitic structure of piston pin drawn at 350 deg. Fig. 47—Inclusion showing as hair line in surface of crank shaft. Fig. 48—Inclusion in same shaft some distance from Fig. 47.

High tension or aviation wire and cable of an average analysis of 0.75 per cent C, 0.60 Mn, 0.032 P and 0.027 S, has a tensile strength of about 250,000 lb. per sq.in. The ends of these wires and cables are made into loops and soldered.

When soldering the loops on the ends of wire and cable, due care should be exercised not to draw or anneal the steel. It is good practice to have some kind of a temperature control on the soldering baths, if used instead of irons or in connection with irons. Acid fluxes cause corrosion especially when the cables are on sea planes and salt water comes in contact with the part already affected. Where acid attacks the surface of the steel, the weakened area formed by the corrosion acts like a file cut, and vibration soon causes the rest, resulting ultimately in rupture under strain.

Chrome-Nickel Steel

Chrome-nickel steel is made into piston pins, connecting rods and crank shafts, steam-line wire, etc.

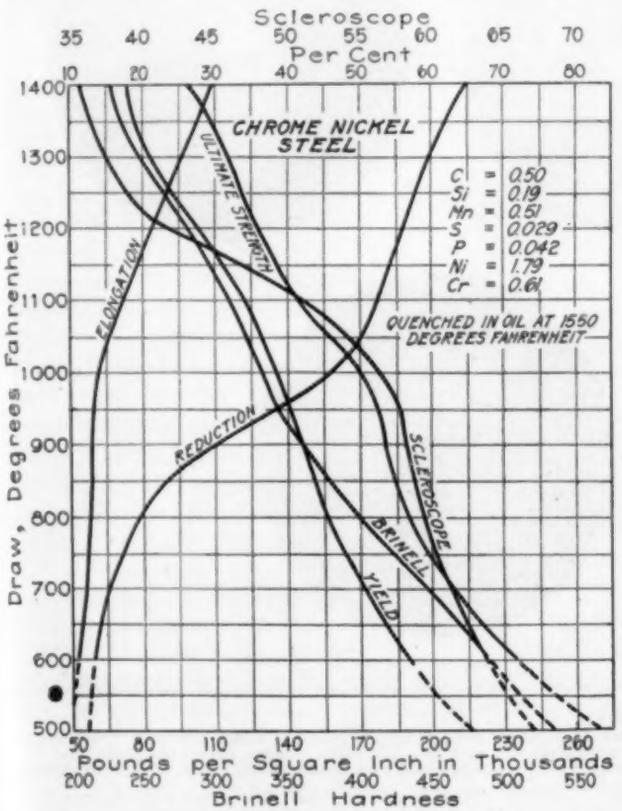


PLATE 4.—PROPERTIES OF CHROME NICKEL STEEL

It is good to resist shock and has a high tensile strength. The presence of both chromium and nickel produces a steel that has a high elastic limit combined with increased elongation and reduction, greater hardening power, and wears much better than carbon steels. This steel is especially valuable in parts that necessitate a heat treatment as it yields a find martensitic structure superior to carbon steels. It resembles the 3½ per cent nickel steel when carbonized in that it may be quenched at about 1550 deg. and refine both the case and core at the same operation.

A typical chemical analysis of this type of steel is C 0.30 per cent, Si 0.19, Mn 0.51, S 0.029, P 0.042, Ni 1.79, and Cr. 0.61.

Raw stock physical properties:

Ultimate tensile, lb.	122,000
Yield, lb.	108,800
Reduction, per cent	55.8
Elongation, per cent	13.0
Brinell	255
Scleroscope	40

Quenched at 1550 deg. and drawn at 900 deg.:

Ultimate tensile, lb.	180,000
Yield, lb.	150,000
Reduction, per cent	40
Elongation, per cent	13
Brinell	360
Scleroscope	56

There has been some trouble in heat-treating this material, piston pins especially often showing hardening cracks. It is sometimes a good plan to double-quench this material before drawing, at 1575 deg. then at 1500 deg. in oil or hot water, being careful to quench the pins vertically. This seems to give a much better result.

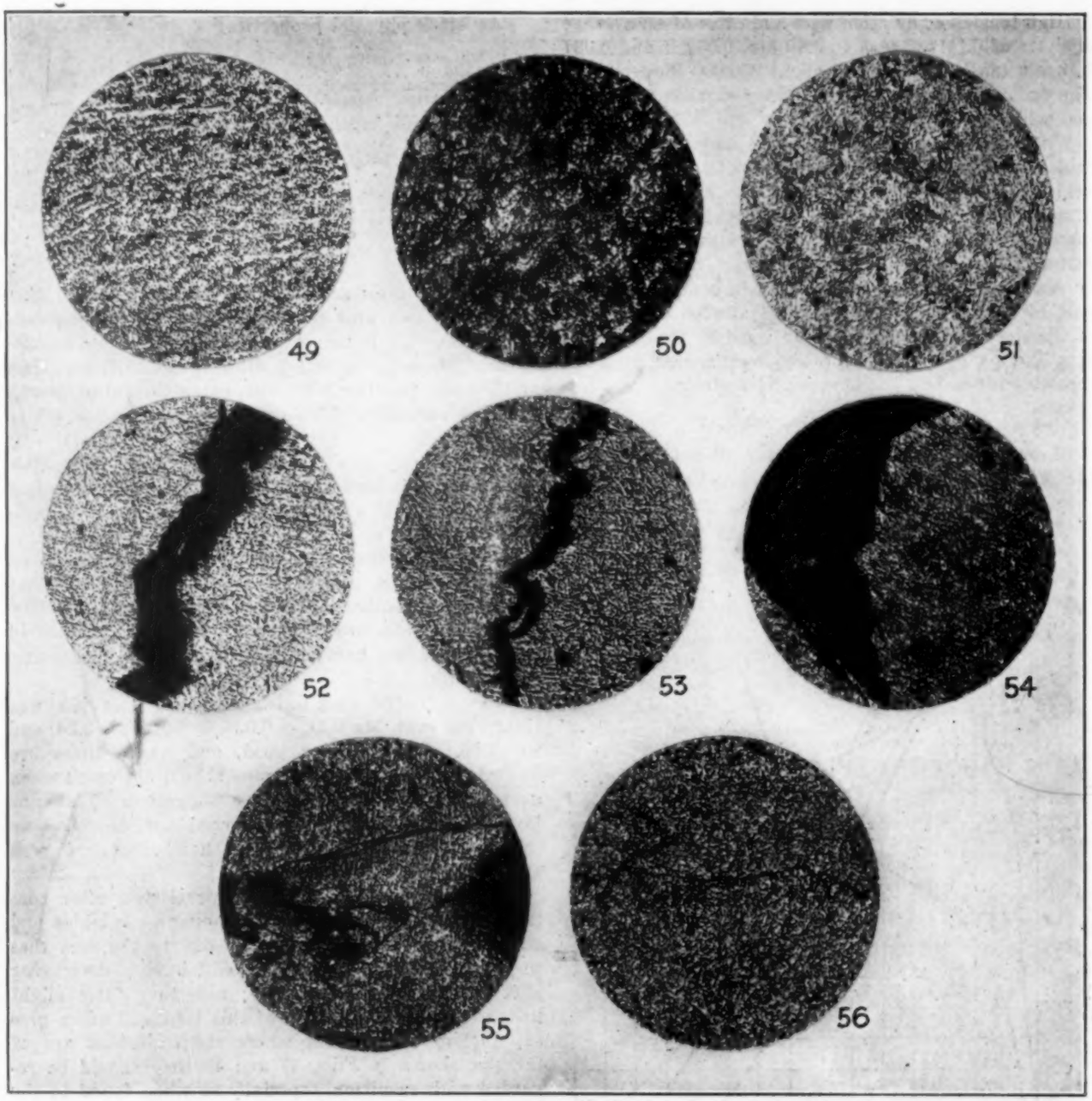
The following is a typical illustration of poor heat-treating of this kind of steel. A piston pin broke after a ten-hour run in a motor. The section showed a hardness of 79, and on being drawn at 850 deg. for thirty minutes scleroscoped 55. The photomicrographs (Figs. 45 and 46) show that the pin was too hard and that it was full of hardening cracks, eight being found. The section that was drawn shows a sorbitic structure in which the ferrite has followed the original martensitic needle lines.

Summary—The chemical analysis of this pin was C 0.38 per cent, Mn 0.51, S 0.026, P 0.018, Ni 3.24, and Cr. 1.25. This is very good, and where there are no bad inclusions or seams, pins should not crack when quenched and drawn as before suggested. The pins investigated were probably quenched cold which set up internal strains that yielded the hair cracks. It was apparently not drawn.

Crank shafts made of chrome-nickel steel often contain hair lines or inclusions of manganese sulphide and silicate. They are objectionable due to the fact that they form surface cracks that will have a destroying effect on soft metal bearings; also they form slight lines of weakness. Cranks of this type will often give satisfactory results, but where the inclusions are of the size shown in Figs. 47 and 48 they should be regarded with suspicion, especially so when found in the "cheeks" of the shaft.

In considering the acceptance or rejection of such a shaft the location, size and type of inclusion should be taken into consideration. The inclusion shown in Fig. 48 was about 0.022 in. in depth and in case of its occurrence in a part of the shaft subject to torsion there is no question but that there is danger of failure, especially when there is poor alignment of bearings. These defects result from poor metallurgy, but by the proper proportioning of Al, Si, and Mn, could be done away with. This would increase the piping but this defect could be removed in the discard. The so-called snow flake does not occur in shafts of this analysis. The particular shaft that showed these hair lines had a composition of C 0.33 per cent, Mn 0.64, P 0.026, S 0.038, Cr 0.78, Ni 1.32 and had the following physical properties:

Ultimate strength, lb.	150,000
Yield point, lb.	120,000
Elongation, per cent	18
Reduction, per cent	56



FIGS. 49-56

Figs. 49 and 50—Mixed structure in crank shaft resulting from poor heat treatment. Photos taken at some distance from each other. Fig. 51—Same section as Fig. 40 given proper heat treatment. Figs. 52 and 53—Hair-line cracks in crank shaft due to improper quenching. Fig. 54—Pipe in gas pocket in crank shaft. Fig. 55—Torsional cracks in crank shaft. Fig. 56—Snow flake, due to forging at too low temperature.

Another shaft investigated failed in service. Sections taken from it had a chemical analysis of C 0.39 per cent, Mn 0.78, S 0.034, P 0.012, Ni 1.42, and Cr 0.82, and physical properties as follows:

Ultimate tensile, lb.	142,000
Yield point, lb.	125,000
Elongation, per cent	18.7
Reduction, per cent	55.4
Brinell	256
Scleroscope	48

From one end of this shaft to the other there was a variance of 42 to 52 on the scleroscope and 241 to 256 on the Brinell. The photomicrographs showed a mixed structure which probably resulted from poor heat treatment.

Figs. 49 and 50 were taken from the shaft at some distance apart, etched with nitric acid and photographed at a magnification of 100.

Fig. 51 shows the section illustrated in Fig. 49 after having been given proper treatment—a very fine sorbite. Quenched at 1600 and 1500 deg. in oil and drawn at 900 deg.

The shaft failed because of poor heat-treatment varying the physical properties of the shaft. It might also have been assisted by the bearings not being true. This has been found true in other cases of failure.

Some shafts are spoiled by quenching improperly. This gives rise to hair-line cracks. Hair-line cracks must not be confused with hair-line inclusions. The quenching medium should not be too rigid or abrupt, as cold water. Figs. 52 and 53 show hair-line cracks. They were about one-fourth of an inch deep and are sufficient cause for rejection. Shafts should be quenched in oil or warm water.

The faults in the shaft shown in Fig. 54 are due to a poor billet. They are pipes or gas pockets and probably could have been avoided by a larger discard. The serrated lines here shown in Fig. 55 are probably torsional cracks. This is a very serious defect, much more so than inclusions.

Snow flake as shown in Fig. 56 is a fault arising probably from forging at too low a temperature. It is a condition peculiar to steel of a higher nickel content.

Crank Shaft Summary

The inclusions shown are of manganese sulphide and silicate. Sulphur prints show considerable discoloration from these areas.

Some shafts have stood up very well after a 100-hour run, while others show that cracks have begun to grow from the inclusions and still others have failed entirely, the failure being traced to the inclusion. As these inclusions can be avoided, and since they are unquestionably lines of weakness and do cause failures, why argue over their acceptance?

Hair cracks are sometimes traced from quenching in cold water. Sometimes they are started by improper forging (forging strain). The cracks shown between the gas pockets in Fig. 54 would appear as hair cracks. Heat-treatment when not conducted properly will give a bad shaft. Variance of temperature in the furnace and crude quenching methods are the principal factors. Some pyrometers are found to be incorrect as much as 200 to 300 deg. F. Too much attention cannot be paid to the proper treatment of crank shafts. The gas pockets shown may be secondary pipes and the cracks connecting the pockets may be pipe-cracks (expansion and contraction). A pipe generally can be removed by properly discarding the top section of the ingot, by bottom pouring, or by the use of molds having a greater top diameter than bottom. In the case of green steel there are local gas pockets and this illustration may be one.

Snow flakes occur in this steel because of poor mill practice. The manufacturer in trying to rush the heat sometimes pours while green. This will sometimes give a condition as here shown. Furthermore, if a high-nickel bar of this steel be forged at too low a temperature there might be a condition such as this. I prefer to think that the fault herein shown traces its origin to poor mill practice.

(To be continued)

The First Veritable Platinum Ingot was made by a French chemist, Chabanean, in 1783. Charles III of Spain had called him to Madrid and created a special chair of minerology, physics, and chemistry for him. Here in his laboratory he found the secret for rendering the new metal malleable, and astonished the court by the weight and lustre of his first ingot.

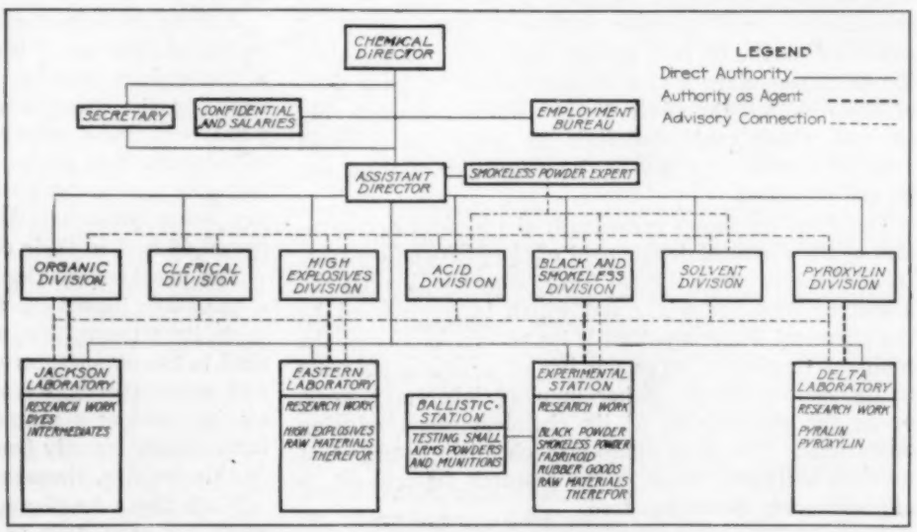
Developments in Industrial Research*

By Charles L. Reese
Chemical Director, E. I. duPont de Nemours & Co.

THE duPont Company started its research department June 1, 1902, by establishing what is known as the "Eastern Laboratory," at Gibbstown, N. J. A force of five chemists, including the Director, constituted its personnel. The Director's duties were two-fold: First, directing laboratory research work, and second, studying chemical operations of the high explosives plants.

In 1903, a second experimental laboratory, known as the "Experimental Station," was established in Wilmington to handle work specifically for the development department of the company. This was later extended to include also work in connection with the manufacture of black and smokeless powder.

In 1912, the "Delta Laboratory" was established for the purpose of investigating problems in connection with the manufacture of pyralin or celluloid, and in 1917 the "Jackson Laboratory" was established in connection with the dyes industry. All these experimental laboratories were placed either at, or in close proximity to manufacturing plants, in order to facilitate the study of plant problems.



PLAN OF RESEARCH ORGANIZATION

Very soon after the establishment of the Eastern Laboratory, it was found desirable to have a head of the research department at the main office in Wilmington, Del., where the duPont Company's executive work is centralized, in order to provide a clearing house for the several research laboratories, and to have available a force of expert chemists who could not only keep in touch with actual manufacturing operations at the various plants, but who could act in a consulting capacity to the various departments. At the same time it was found advisable to centralize all chemical research work under one Chemical Director, and accordingly the Experimental Station, which had been connected with the development department, became a part of the chemical department organization.

*Delivered at the meeting of the American Society for Testing Materials, Atlantic City, June 26, 1918.

The growth of the research activities since the establishment of the Eastern Laboratory in 1902 is well shown by the following tabulation, which gives the number of salaried employees, and the salaries paid per month during the last ten years:

	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	June, 1918
Employees..	55	75	92	111	111	115	95	160	200	395	475
Salary per month....	8,000	10,000	12,000	13,000	14,000	14,500	13,000	20,000	26,000	55,000	92,000

Not only has the number of salaried employees increased considerably during these ten years, but the salary rates have very decidedly increased, although this is not true of the average salary per man, due to the increased proportion of younger men employed during the last few years. Furthermore, as indicated by the accompanying curve, the total yearly expenditures for research work have grown from fifty thousand to two million dollars. This growth in research activity shows clearly that the duPont Company considers its research department a distinctly profitable undertaking.

During the period from 1912 to 1915, the total expenditures for research work amounted to approximately one million two hundred thousand dollars; while the total savings, direct or indirect, accomplished by this expenditure were fourteen million dollars. It is, of course, difficult, in fact almost impossible, to calculate the exact pecuniary saving brought about by many lines of research, but the above figures, which represent only savings which could definitely be traced to research activities, give some idea of the magnitude of what can be accomplished.

The diagram shows graphically the present organization of the chemical department of the duPont Company. In addition to the chemical force, which is directly engaged in research work, and which is represented by the chemical department with its several branches, the company employs a large number of graduate chemists in its various plants, either in plant laboratory work, or in the supervision of its chemical manufacturing operations. The total number of chemists employed at present, including those in the research department, is approximately eleven hundred.

Direct and Indirect Financial Returns

The first important problem undertaken by the research department, when established, was a study of a difficulty met with in works operations, in the separation of nitro-glycerine from waste nitrating acid. After a few months' study this problem was solved by the discovery of the presence of colloided silica in certain brands of glycerine, which colloided silica hindered the separation of the nitro-glycerine from the acid. It was found that by the addition of minute quantities of sodium fluoride, the separation could be reduced from a period of two hours to one of but a few minutes. By this reduction in the time of separation, an enormous saving in time and cost of manufacture was accomplished, and the research department received immediate recognition.

From the first beginning to the present time, progress in research has been like a triumphal procession. Investigations of existing manufacturing processes led to changes in the manufacture of nitro-glycerine, nitric acid, sulphuric acid, and ammonium nitrate, all of which are raw materials for the manufacture of dynamite, nitrocellulose and ether for smokeless powder manufacture, and acid and solvent recovery; they have enabled us to obtain practically theoretical chemical yields in the manufacture of these products; and by improvements in machinery, equipment, methods of handling and by substitution of mechanical processes for labor, they have accomplished savings of millions of pounds of raw materials and a corresponding monetary saving.

Without going into this matter in detail, I wish to mention several developments which have occurred since the beginning of the war, and which will contribute in no small measure to a final successful end of it.

In 1914, when the British embargo cut off the supply of German potash salts, the duPont Company was in a position to undertake the immediate production of potash salts from its nitrate deposits in Chile, as the research department had already discovered the presence of these salts in these deposits, and had worked up a satisfactory method for their extraction. This achievement not only assists in helping to meet the shortage of potash salts, but insures a supply for the manufacture of black ignition powder, which is absolutely necessary for igniting and firing charges of smokeless powder in our large guns.

A threatened shortage in the supply of sheet lead, and an actual shortage of lead burners and the necessity for a tremendous increase in the production of sulphuric acid for the manufacture of explosives made it imperative to find a substitute for lead in the construction of sulphuric acid plants. This problem was solved satisfactorily, and to-day millions of pounds of sulphuric acid are being manufactured in plants which have not a pound of lead in their construction.

The problems of the manufacture of diphenylamine, a necessary ingredient in smokeless powder which prevents its deterioration, and of the raw material, aniline, used in the manufacture of diphenylamine, were quickly and satisfactorily solved in American research laboratories; and this ingredient, which was obtainable in large quantities only from Germany, is now manfactured in this country, thousands of pounds per day.

While these developments and achievements illustrate what has been done in the way of supplying requirements, or furnishing substitutes for raw materials difficult or impossible to obtain, the accomplishments in the field of conservation of material have been as great, if not greater. Two might be mentioned here which, from the standpoint of magnitude, are well worth noting. In the manufacture of the type of powder employed by the United States Army, and now largely employed by the Allies in Europe, large quantities of alcohol and ether solvent are required. On account of the volatility of both of these substances, large losses take place during the manufacture of powder. By studying carefully these losses in the places where they occur, changes in manufacturing operations were made possible which enabled us to save solvent which, under the present scale of manufacturing powder, would amount to some fifty million pounds per year. Likewise, in the manufacture of guncotton, where large quantities of nitric acid were lost several years ago, we have been enabled by careful study to make changes which have accomplished a saving equivalent to some forty-five million pounds of nitric acid a year. When it is remembered that heretofore nitric acid has been manufactured almost entirely from

Chile saltpetre, and that the scarcity of shipping has made it difficult to maintain an adequate supply of this material, which is so essential for the successful raising of large crops, it will be realized what the chemical research of this one company alone has been able to contribute to the successful termination of the war, aside, and in addition to, the production of actual military explosives.

Before the United States entered the war, the demand for toluol became so great, and the price so high, that two distinct methods for the synthetic manufacture of this material were developed. Two methods for the manufacture of picric acid were also developed and operated satisfactorily.

There is a high explosive used for primers in military explosives, as well as in blasting caps, known as tetryl, or tetranitromethylaniline. A process for the manufacture of tetryl or tetranitromethylaniline was developed and put in satisfactory operation, as well as the process for manufacturing dimethylaniline.

Because of the extensive program for the manufacture of high explosives planned after the United States entered the war, it became necessary to develop other high explosives than trinitrotoluol, picric acid and ammonium nitrate, and within a very short period the research department developed four new high explosive materials, all of which have been adopted by the Government, and will materially relieve the situation.

It is hardly necessary to call attention to the developments carried on by the research laboratories, of not only the duPont Company, but also of a great number of other concerns which have resulted in a very satisfactory solution of the dye situation in this country, so that in a short time we will be producing all the important dyes which we were of necessity importing from Germany before the war.

These instances from the experience of one company could be multiplied many times and the list of accomplishments of every large industrial corporation maintaining an adequate staff of research chemists could be greatly extended. As it is, I have only indicated the general trend toward an increased amount of research work as evidenced by the expansion which has taken place in the duPont Company, suggesting the possibilities in saving, in conservation of resources, and in increasing efficiency which can be accomplished by such a systematized and well organized research work.

The President has issued an executive order authorizing the Secretary of War to employ, without reference to the requirements of the civil service act, such persons in the research division, Chemical Warfare Service, at the American University, as may be needed in conducting certain investigations and construction work relating to gases and chemicals used in war, it being understood that all possible use will be made of the registers of eligibles of the Civil Service Commission. This authority shall continue only during the present war. The Commission concurs with the War Department in recommending this order because of the urgent and highly confidential character of the work involved and the fact that it must be organized and prosecuted with the greatest dispatch and be safeguarded most effectively.

"Caliche" Beds Found to Be Small in Southeastern California

REPORTS were circulated in 1917 that large deposits of sodium nitrate were in Amargosa Valley, Ingo County, California. The Geological Survey has made an extensive search without finding verifications. In all, 78 trenches were dug, which had a total length of 3700 feet and an average depth of 2 feet 11 inches; 959 pits were dug to an average depth of 1 foot 7 inches; 1085 samples were taken, from which 930 analyses were made. In the so-called Upper Canyon field, at Acme Siding, 98 acres is estimated to contain 1480 short tons of sodium nitrate, but an overburden of about 100,000 tons would have to be removed in order to extract the caliche containing this nitrate. In the so-called Lower Canyon field 70 acres is estimated to contain 510 tons of sodium nitrate, the recovery of which would involve the removal of an overburden of about 50,000 tons. These two tracts are the largest and best of the ground examined, and, taken together, include 168 acres, which, if workable, might yield 1980 short tons of sodium nitrate, the recovery of which would involve the removal of 150,000 tons of overburden. The result of examinations at other places do not justify estimates of tonnage of nitrate.

The Survey's explorations have led to the following conclusions:

1. The nitrate in the Amargosa district occurs in a blanket of so-called "caliche," about 5 inches in average thickness, which lies about 9 inches below the surface of the ground. The nitrate is accompanied by other salts, chiefly sodium chloride.

2. The soil above and the bedrock below the deposits contain insignificant amounts of nitrate.

3. The high dip and the great thickness of the strata covered by the prospecting make it improbable that deeper beds of nitrate occur in this region.

4. The caliche in general contains an average of less than 2.5 per cent of sodium nitrate, the areal distribution of which is uneven.

5. The Zabriskie field, in which the newly found deposit was reported to lie, contains no commercially valuable nitrate.

6. The Upper Canyon and Lower Canyon fields, the most promising in the Amagosa district, together contain, according to careful estimate, about 168 acres of niter-bearing deposits, which, if worked regardless of cost, might produce about 1980 short tons of refined nitrate.

7. The quantity of nitrate available in the Amargosa district is so small and the cost of production would be so great that the district as a whole can not be regarded as a source of commercial nitrate.

8. No further work on the areas already examined is justified, except, perhaps, that in the nature of purely scientific research.

9. The occurrence of caliche nitrate deposits in the Amargosa district, rather than the usual cave or disseminated deposits, makes it seem possible, though improbable, that really valuable deposits of nitrate may occur elsewhere in the same general region.

10. Prospecting should be continued until all similar deposits in other districts have been tested sufficiently to determine their value.

Aluminium and Its Light Alloys—II

The Technology of Casting, Hot and Cold Working—Production of Tubes and Foil — Composition of Fluxes and Solders—Effect of Mechanical Work and Heat Treatment on Physical Properties

BY PAUL D. MERICA

VII. TECHNOLOGY.

1. CASTING

PRACTICALLY no aluminium is poured into sand or even chill castings today except for the production of rolling or melting ingots. "Aluminium" castings are made of an alloy of aluminium with copper, zinc or other metals; the subject of casting alloys of aluminium is discussed below.

For rolling and drawing aluminium is heated without flux in reverberatory or in crucible furnaces and poured into chill molds. Care is taken in melting to keep the temperature below 800°C; above this temperature the aluminium absorbs gas, oxidizes and a porous ingot may result. The melting is usually done at from 725 to 750°C. Quick cooling in the chill ingot molds is very necessary in order to secure a fine grain, and consequently good mechanical properties, as well as ease of hot rolling. When starting to pour a chill mold for rolling ingots the mold is held at an angle, such that the metal flows down one side and does not splash. During the pouring the mold is continually and slowly tilted into the vertical position. In this manner cold sheets and similar flaws are prevented.

2. WORKING

Sheet aluminium is usually rolled from one of the standard rolling ingots (see p. —). The ingots are reheated after casting to about 400°C and rolled down hot in from 10 to 12 passes to a sheet, ¼ to ⅜ in. thick. This is then rolled cold to gage without intermediate annealing. Sheet as thin as 0.0005 in. may be rolled; this is of course foil. If soft sheet is desired the cold-rolled sheet is annealed, generally at from 375 to 400° C for 18 to 30 hours, and cooled in air.

Rods and wire are first hot rolled and then drawn cold to size, the methods differing but little from those in vogue for copper. Wire for example may be rolled hot from a square section billet weighing about 85 lb. (usually about 4 in. square in section and 5 or 6 ft. long), to from ½ to ⅜ in.; these rods are drawn cold to the wire sizes desired. Sometimes, particularly in European practice, all of the rolling is done cold instead. Tallow is used as a lubricant and the wire may be drawn at from 150 ft. (initial) to 600 ft. per minute final speed.

Tubes are made by the cupping of plates, followed by drawing on the press and then on the standard draw bench; this is done cold with intermediate annealing if necessary.

Sections, rods and tubes are also made by extrusion at higher temperatures, about 400°C, by hydraulic pressure. Sections up to 6 in. in diameter are made in this manner with wall thicknesses of as small as ¼ in. Continuous tubing may be made also by this method.

Aluminium is very readily stamped, drawn and spun; cooking utensils and vessels of various kinds are produced by spinning annealed aluminium sheet. "In thicknesses above No. 20 B. & S. gage, aluminium will take a draw of from ¼ to ½ more depth than will copper, brass or steel."

Aluminium foil, 0.0005 in. in thickness may be still further beaten into aluminium leaf almost as fine as gold leaf.

Pure aluminium is not readily machined; the metal drags, the tools do not cut but tear; files are "smeared" with the metal. The alloys of aluminium are much more readily machined; particularly the casting alloys. For the metal and its alloys the tool should be sharp with a good clearance, as for wood; the cut should be light and made under a suitable oil such as lard oil or the same mixed with 3 parts of benzine. A cutting speed somewhat greater than that used for brass is suitable.

3. WELDING AND SOLDERING

Aluminium can be both soldered and welded, the latter by several different processes. In both cases a principal difficulty consists in the removal of the layer of oxide before the metal can flow together.

Aluminium may be welded by any of the different commercial processes. Aluminium sheet is generally welded by the oxy-acetlyene or oxy-gas torch, the edges being butted for all but light gages, for which they are lapped or flanged. A flux should be used for sheet welding, and consists of a mixture in varying proportions of the chlorides and fluorides of sodium, potassium, lithium, aluminium and calcium. A few typical compositions of fluxes are given in table VI below. These fluxes should be finely powdered and before using moistened down with alcohol.

TABLE VI—PERCENTAGE COMPOSITION OF WELDING FLUXES
(Pannell, 44, and others)

	Sodium Chloride	Sodium Fluoride	Sodium Sulphate	Lithium Chloride	Potassium Chloride	Potassium Fluoride	Potassium Sulphate	Calcium Chloride	Cryolite
1	30	..	3	15	45	7	..	..	..
2	..	33	..	33	33	..	..	..	..
3	12.5	..	..	30.8	62.5	..	4.0	..	..
4	16	..	..	..	79	..	5.0	..	..
5	17	..	..	..	83	..	..	..	..
6	6.5	..	4.0	23.5	56	..	..	..	10
7	..	..	..	..	60	..	..	30	6

The flame must not be held so close to the work as in steel welding, and a slightly reducing flame is to be used. A feeding stick of the same composition should be used; if the joint edges are flanged a feeding stick is not necessary.

Castings may be welded in the same manner, except that it is not necessary to use a flux, although results are generally better when it is used. The casting should be well supported so that no stress comes upon the welded joint while it is hot, as the metal is fragile and brittle at a temperature below the melting point.

In welding work on castings, the latter should preferably be pre-heated in order that internal stresses caused by shrinkage are not left in the welded casting when cool.

Arc welding may also be used for repair work on castings, but is not used for sheet and thin work.

Rods and wires are best butt welded by a combined heating and pressure method. The older methods of Heroult and of Cowper-Coles consisted in squaring off the ends of bars, heating these ends to about 400°C and bringing them together and hammering them (Heroult) or under pressure (Cowper-Coles). The electric resistance butt welding machines have however, furnished a much more suitable means of heating and applying pressure than the older processes and are in general use.

Spot-welding of sheet aluminium has been done but does not seem to give as reliable a joint as the oxy-acetylene process.

Welding, chiefly oxy-acetylene, is now quite widely practiced, both on aluminium castings and on sheet. Large numbers of welded aluminium vessels, pans, and containers of various sorts are manufactured each year. The welds are in most cases so perfect that the weld cannot be detected in the finished article. However, the welding of aluminium by any of the above methods is not easy, and requires experience. Welders familiar only with iron and steel work will generally make a complete failure of their first aluminium work.

Although welding is the only process to be recommended for joining aluminium when the joint must have strength and is exposed to the weather, it may in many instances be advisable to solder aluminium articles instead of welding them. The application of solder is easier, requires no especially skilled operator and the temperature of application is not so high as to cause buckling or distortion in the welded piece. On the other hand the metals used in such solders are all electronegative to aluminium; a soldered joint is rapidly attacked by water or moisture, the joint becoming completely disintegrated in a short time. Only when the joint may be varnished or protected or for very heavy joints where slight corrosion would not be serious should solder be used.

It would be useless to give a list of all of the recommended solders for aluminium now on the market. They consist for the most part of varying mixtures of zinc, tin and aluminium of which Table VII will give some typical examples of those most generally used. Some mixtures contain copper, lead, bismuth, antimony, and iron, the function of which is certainly not clear; in fact these metals are probably harmful.

TABLE VII—PERCENTAGE CHEMICAL COMPOSITION OF SOME ALUMINIUM SOLDERS

Reference	Zinc	Tin	Aluminium	Lead	Copper	Cadmium	
Burgess & Hambuechen (146)	21	76	3	...	....	..	
Richards (258)	63	31	3	...	....	..	Phosphor-tin—3
Auel (236)	35	63	0.25	...	2	..	
Wust	50	....	30	...	20	..	
Wust	65	....	20	...	15	..	
Wust	80	....	12	...	8	..	
Wust	85	....	9	...	....	..	Brass—6
Wust	88	....	7	...	....	..	Brass—5
Wust	90	....	6	...	....	..	Brass—4
Wust	94	....	4	...	2	..	
Bates (257a)	....	30	70	...	....	..	
Bates	....	....	81	...	19	..	
Bates	....	20	70	...	10	..	
Sterling	15.2	61.6	11.2	8.3	2.5	..	Antimony—1.2
Roesch	50.2	48.6	....	...	0.2	..	Antimony—0.7
Bureau of Standards							
Sn 1	8	78	9	...	....	5	Phosphorus—0.25
Sn 3	9	86	5	...	....	..	
Sn 4	9	86	5	...	....	..	
Zn 1	75	....	5	...	....	20	
	90	....	6	...	4	..	

Solder is best applied without a flux. The edges of the aluminium are filed clean and tinned with the solder, which should be thoroughly rubbed into the surface with a wire brush or with waste. The joint is then readily made in the usual manner between the tinned surfaces, using an iron if necessary.

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There are a number of patents claiming the accomplishment of these two operations. The firm, Mix and Genest, have given a great deal of attention to this problem and describe in their patents a number of processes for the preparation of the metal for the plating bath. Some of them are:

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Canac and Tassilly (260) describe a long process depending on the cleaning of the aluminium with KOH or K_2CO_3, brushing with milk of lime, dipping in 2% KCN, dipping in a solution (A) of 500 gr. HCl, 500 gr. water, 1 gr. iron, followed by washings and repetition alternately of dipping in solution (A) and water until, as they claim, an adherent coating of iron has been produced upon the aluminium, upon which copper or any other metal must then be deposited in the usual manner.

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5. MISCELLANEOUS

Finish. Aluminium is given several types of finish; the two most important are the polished and the satin finish. The former is obtained in the usual manner by buffing with rouge. The latter is obtained either:

(1) by caustic dipping; the metal is cleaned in benzine, dipped in boiling concentrated caustic soda, washed, dipped in hot, strong nitric acid, washed in boiling water and dried very quickly.

or (2) by scratch-brushing; the metal is carefully freed from grease and then brushed on the wire brush wheel.

Granulating. Granulated aluminium has been used in the manufacture of steel. It is made by pouring molten aluminium in thin streams into cold water, which is stirred. The metal may for this purpose be poured through a sieve.

Calorizing. Ruder (46) describes a process of coating metals with aluminium by heating in a mixture of aluminium and aluminium oxide at higher temperatures. This is accomplished at from 700 to 800° for copper and from 900 to 950° C for iron and steel. The layer formed varies from 0.025 per cent to 0.010 mm. in thickness.

Aluminium has been applied by the Schoop process.

Aluminium powder for painting and the thermit reaction is produced by rubbing foil through a metal sieve under molten fat.

VII. The Properties of Aluminium as Affected by Mechanical Work and by Heat Treatment

When aluminium is cold worked the hardness or tensile strength is increased and the ductility or elongation in the tensile test decreased. The manner in which these properties vary with different amounts of cold working is shown in Figure 9, drawn from data

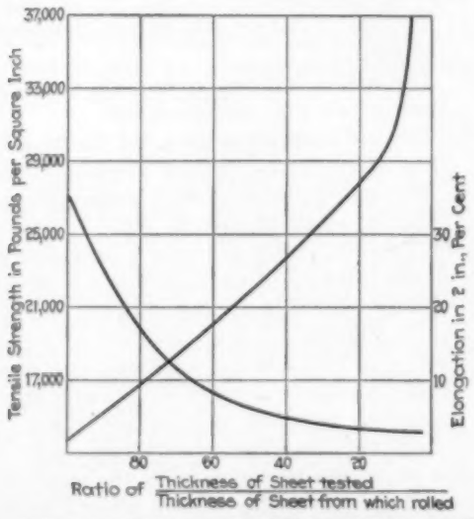


FIG. 9.—EFFECT OF COLD WORKING ON THE TENSILE PROPERTIES OF ALUMINIUM SHEET

kindly supplied by the Aluminum Company of America from tests on cold rolled sheet.

The Shore scleroscope hardness number (magnifying hammer) increases also from 5 to 6 for annealed aluminium sheet, to from 15 to 20 for hard sheet.

Annealing produces a recrystallization and softening of the metal. Only recently, Carpenter and Taverner (207) have made a systematic study of the rate of softening of aluminium sheet, by annealing at different temperatures. They used sheet cold rolled to 0.125 in. (probably from ⅛ inch, but the exact amount of cold reduction was not known to the authors), of four materials of the following average analysis: Silicon, 0.75 per cent (0.70 to 0.81); iron 0.34 (0.34 to 0.36); copper, 0.03.

A general idea of the results of their tests is gained from Figs. 10 and 11. The principal facts developed by this investigation are:

(1) The hardness caused by mechanical work is lost very rapidly upon annealing at from 300 to 500°C. The

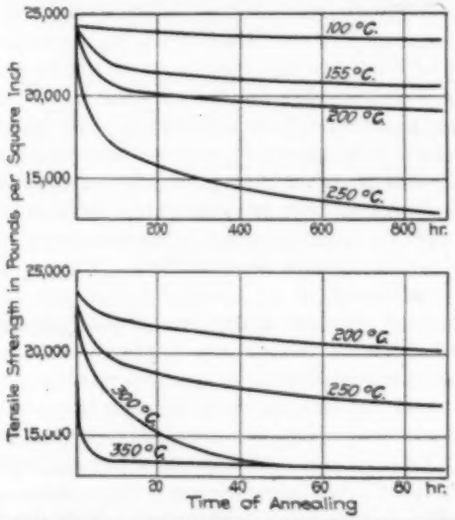


FIG. 10.—EFFECT OF ANNEALING ON TENSILE STRENGTH OF COLD-WORKED ALUMINIUM (CARPENTER AND TAVERNER)

same final tensile strength of about 12,700 lb. per sq. in. is obtained in all cases.

(2) The softening is most marked within the first portion of the annealing period.

(3) No hardening by annealing was noticed as in the case of copper and brass.

(4) Below 300°C. the decrease in hardness is very slow, but occurs within the temperature range of 100 to 200° with no increase of ductility.

The authors did not study the effect of previous cold reduction on the rate of softening by annealing, but

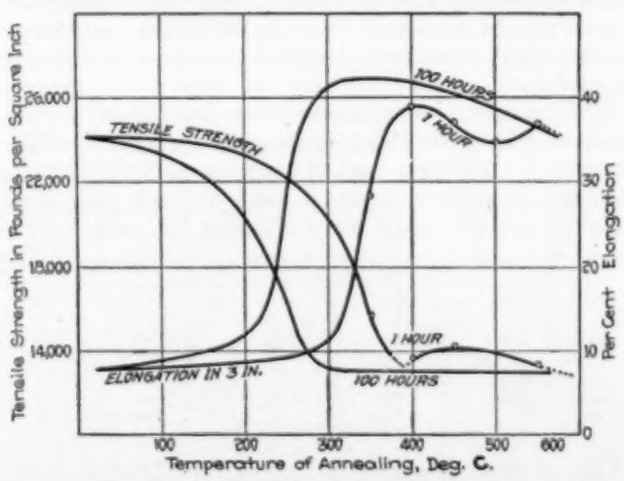


FIG. 11.—THE ANNEALING OF COLD-WORKED ALUMINIUM (CARPENTER AND TAVERNER)

there is no doubt but that the extent of this reduction has a great effect upon the annealing of the metal, as has been shown to be the case with copper.

Some annealing tests on aluminium tubes are described by Breuil (204).

(To be continued)

The Deresination of Rubber—II

Description of a Plant for Producing About 400 Tons of Deresinated Guayule per Annum — Specific Gravity Tables for Solvents — Tables for Determining Mixed Solvents.

BY ANDREW H. KING

THE deresinating plant of which Fig. 1 is a diagram, was a small one having a maximum capacity of about 400 tons of deresinated Guayule per year. It was housed in a two-story brick and steel building 50 feet wide by 150 feet long, and 32 feet high. Both floors were concrete, carefully sloped to drains placed at frequent intervals. The equipment consisted of two washers, two vacuum dryers, three churns, five kettles, six condensers, a recovery tower, pumps, and numerous tanks. On the first

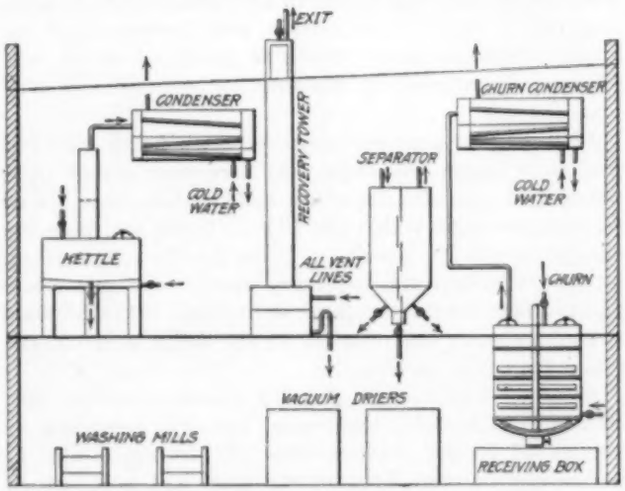


FIG. 1—DIAGRAM OF A DERESINATING PLANT

floor were the washing rolls and vacuum dryers. The churns were suspended from the second-story floor beams and projected only about a foot into the upper story. Underneath them were large receiving boxes. The rest of the first floor served for storage. Most of the apparatus was on the second floor, the kettles in a row on one side and the churns on the other. The condensers were suspended from the roof trusses. The recovery tower, into which all the condensers, churns, and separator were vented, was placed at one end of the room and the separator at the other. The pumps and most of the valves were situated in the middle of the room. On the roof a cooling device was installed for cooling condenser water. This consisted of many feet of pipe which was kept wet with water. Steam was supplied from the main power plant some distance away.

Churns. The churns were cylindrical in shape, with bulged bottoms. They were made of boiler iron $\frac{3}{8}$ inches thick on the sides and $\frac{1}{4}$ inch thick on the bottom and top. The capacity of each was about 2300 gallons. The internal measurements were 8 feet deep by 7 feet in diameter. The churn was charged through two iron doors 20 inches in diameter placed in the top, which, when closed, were pressed by screw clamps into special gaskets. Discharge was through a 16-inch gate valve attached at the bottom. Four pairs of paddles mounted on a 3-inch shaft supplied the necessary agitation. The paddles were 40 inches, 58 inches, 76 inches and 106 inches respectively from the top. The bottom pair were curved so as to produce an upward current in the churn. There were three pairs of stationary paddles which also served to stay the shaft and keep it straight during operation. A 15-hp. motor supplied sufficient power for the three churns. The paddles could be rotated in either direction by means of a clutch. Liquids were pumped into the churn through a 6-inch line entering at the top. By teeing and suitable valves this line also served to carry vapors to the condenser during "steaming off" and to connect the churn with the vent system while treating rubber with the mixed solvent.

Following each treatment with mixed solvent a settling period was always allowed, during which the rubber settled to the bottom of the churn. The supernatant liquid was then pumped off by means of a rather ingenuous device. A number of lengths of pipe were connected by swinging joints so that they might be straightened out to almost any desired length. To the end which went down in the tank a "J" shaped affair was attached, as in Fig. 2. The lower legs of the "J" were broad and had a mirror-like polish. The entrance was through an opening in its center. This hole was screened with fine wire, set in after the fashion of down spout guards. By holding an electric light overhead and carefully manipulating the pipes one could pump out the solvent right down to the layer of rubber.

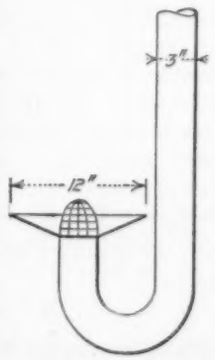


FIG. 2—"J" SHAPED SUCTION DEVICE

Kettles. The kettles should rightly have been classed as pans since they were 8 feet in diameter and but 4 feet high. They were made of $\frac{1}{4}$-inch boiler iron and were steam jacketed only on the bottom. The jacket was built to withstand 200 pounds of steam pressure. Each kettle was supported by three brick pillars 12 inches square and 4 feet high. All pans were equipped with still heads. On four of them the head was 18 inches in diameter by 3 feet high. The other, which ran exclusively on acetone and water, had a head 18 inches in diameter by 7 feet high. There was an elliptical manhole, two feet by one foot, in the top of each kettle. Charging was accomplished through a 4-inch line entering at the top. The bottom of the still had a slight slant so that it would drain properly to the 4-inch line opening out at the deepest point. From the top of the still head a 4-inch line carried the vapors to the condenser. The maximum capacity of each kettle was

about 1400 gallons, but 1000 gallons was a safe charge. When working properly about 300 gallons of mixed solvent could be distilled per hour.

Condensers. The condensers were quite satisfactory when a sufficient supply of cold water was available. The shell of the condenser was 4 feet in diameter by 10 feet long. The pipes were 1 inch in diameter by 8 feet long and were of brass. They were arranged in three compartments and were suitably inclined so that liquid condensed in the first one would flow on through. The top section contained 130 tubes, the middle one 60, and the bottom one 40, making a total of 230 tubes. Vapor coming from the still entered the top section; part of it was condensed, and flowed by gravity into a compartment which connected with the middle section. After flowing through the middle section the liquid and uncondensed vapor entered another compartment from which it passed into the bottom section. Cold water was kept circulating around the tubes within the shell. Vapor entrance was effected through a 4-inch line; condensate exit was through a 3-inch line. Water lines were 3 inches in diameter. A vent pipe connected the lower section with the recovery tower, thus maintaining atmospheric pressure in the condenser.

The condensers did not work properly when the temperature of the cooling water rose above 17° C., so about 1000 feet of 2-inch pipe was arranged in coils on the roof, over which water was kept constantly spraying. Each kettle had its own condenser, while but one was required for the three churns.

Separator. For separating mixtures of acetone and water from acetone and gasoline an apparatus similar to an ordinary separatory funnel was employed. It consisted of a cylinder 5 feet in diameter by 8 feet in height, with a truncated cone 2 feet long at the bottom. The lower section of this cone was 1 foot in diameter. At this point a section of pipe 1 foot in diameter by 2 feet long was attached. Gage glasses were arranged so as to interlock, and one could follow the line of separation all the way from the top to the bottom. The separator was made of ¼-inch boiler iron and was supported by means of brackets resting on brick pillars. Charging was accomplished through a 4-inch pipe entering at the top. A vent pipe opening into the recovery tower was provided at the top. At the bottom were four different lines for carrying acetone-gasoline, gasoline, acetone and acetone-water to and from their respective tanks. The capacity of the separator was approximately 1000 gallons.

Recovery Tower. All churns, the condensers, and the separator had vent lines opening into the recovery tower, thus maintaining atmospheric pressure throughout. This apparatus consisted essentially of a 20-foot stack of boiler iron ¼ inches thick, 2 feet in diameter, with a cylindrical receptacle at the bottom which measured internally 4 feet in diameter by 5 feet deep. The vent line (a 4-inch line) entered the column at the top of the lower receptacle. From the top of the stack a very fine spray of cold water was kept constantly falling. A 3-inch pipe opening from the top of the stack gave access to air. Discharge was through a 3-inch pipe opening a little above the bottom of the lower receptacle. A trap was placed in this line a short distance past the column. Gage glasses were provided for the lower receptacle only. The fine spray of water was particularly efficient in washing out uncondensed acetone.

Fittings. All pipe was made of extra heavy wrought iron with flange couplings. At necessary places sight boxes were provided, in which hydrometers were placed so that one could watch the flow of liquid and note the change in specific gravity. Three double-acting steam pumps furnished the necessary suction for the whole plant. There were ten large cylindrical tanks of 6000 gallons capacity each buried in the earth a short distance from the building.

Solvent. The solvent used for deresinating Guayule, Pontianack, Borneo, Palembang, etc., was composed by volume of 53 per cent acetone (98 per cent) and 47 per cent gasoline. The acetone used had a sp. gr. of .8041 at 15.5° C., and the gasoline was the grade known as 70 to 72° B., the specific gravity of which varies from .6931 to .7000. The grade in use at that time was obtained from Pennsylvania petroleum; practically all of it evaporated below 130° C. Spontaneous evaporation in the open air left no trace of that objectionable oil residue so prevalent now. Some data on the specific gravity of acetone and water mixtures are given in Table II. The percentages of gasoline and acetone given above mix perfectly. The specific gravity of the mixed solvent is .755. Table III contains corrections for specific gravity of acetone at different temperatures.

Method of Operation. **Churns of the size described above require a charge of 1200 pounds of Guayule or 5000 pounds of Ponti. The necessary amount of rubber**

TABLE I

RESIN CONTENT AND WASHING LOSS OF VARIOUS RUBBERS

	Botanical Origin	Geographical Origin	Washing Loss Per Cent	Resin Content Per Cent Based on Washed and Dried Rubber
Plantation Crepe..	Hevea brasiliensis.....	Ceylon and Fed. Malay States....	.2–1	.3–3.6
Plantation Scrap...	Hevea brasiliensis.....	Ceylon and Fed. Malay States....	8–12	2.5–4.5
Islands Fine Para (Soft Cure).....	Hevea brasiliensis.....	South America, Islands Lower Amazon.....	17–20	2–3
Fine Para, Up-river (Hard Cure)....	Hevea brasiliensis.....	Upper Amazon Valley.....	14–19	1.6–3
Caucho Balls.....	Hevea brasiliensis and other Hevea species...	Amazon Dist. and its southern tributaries.....	18–30	3.5–5.5
Sumatra.....	Ficus elastica.....	Sumatra.....	10–25	7–15
Islands Coarse....	Pars Sapium taburu....	Lower Amazon and Islands.....	20–40	2–6
Java.....	Ficus elastica.....	Java.....	10–30	3.7–8.5
Ceara.....	Manihot Glaisovii and other Manihot species	Province Ceara....	25–46	2.5–4
Manicoba.....	Species of Manihot.....	Grande de Norte....	30–55	3 –6.5
Cameroon Balls...	Funtumia elastica and Landolphia owariensis	Africa, Cameroon..	26–45	10–20
Palembang.....	Dyera costulata.....	Sumatra.....	64–70	70–85
Borneo, Pontianak, Jelutong.....	Dyera costulata, chiefly	Borneo.....	64–70	70–85
Guayule.....	Parthenium argentatum	Mexico.....	15–40	23–26

TABLE II.

Acetone and Water

Pure Acetone 100 per cent has a Sp.Gr. of 0.795 at 15.5° C. and boils at 56-57° C.

Mixtures of acetone and water at 15.5°C.

100%	pure acetone has a sp.gr. of		0.795
99	pure acetone, 1%	water, has a sp.gr. of	0.7995
98	pure acetone, 2	water, has a sp.gr. of	0.8041
97	pure acetone, 3	water, has a sp.gr. of	0.8084
96	pure acetone, 4	water, has a sp.gr. of	0.8125
95	pure acetone, 5	water, has a sp.gr. of	0.8164
94	pure acetone, 6	water, has a sp.gr. of	0.8201
93	pure acetone, 7	water, has a sp.gr. of	0.8237
92	pure acetone, 8	water, has a sp.gr. of	0.8272
91	pure acetone, 9	water, has a sp.gr. of	0.8306
90	pure acetone, 10	water, has a sp.gr. of	0.834

is weighed up, then put through the cold washing rolls. With Guayule, no attempt to sheet was made, and no water was used. The rubber was only coarsely broken down. With Ponti, water was employed and the pieces allowed to drain off as much a possible before charging. The partly broken down Guayule was taken to the charging floor, the churn was made ready by closing the 16-inch valve in the bottom, opening the valve to the vent line and by closing all steam lines. The churn was then pumped one-fourth full of the mixed gasoline and acetone solvent, previously adjusted to the correct proportions. Then the paddles were started and the charge dropped in, after which the churn was filled within 6 inches of the top with solvent. The manholes were closed and the churn left running on the first treatment which lasted 2 hours, when it

TABLE III.

Tests for Acetone

Boiling Point 56-57° C. Sp.Gr. 1797
131° F.

Sp.Gr. Acetone and Water Mixtures at 15.5° C.

90% pure	0.834
91 pure	0.8306
92 pure	0.8272
93 pure	0.8237
94 pure	0.8201
95 pure	0.8164
96 pure	0.8125
97 pure	0.8084
98 pure	0.8041
99 pure	0.7995
100 pure	0.7946

Coefficient of Exp. = 0.0011

Corrections for Acetone for Sp.Gr. at Different Temperatures

−	Deg. C.	Deg. C.	+
0.0055	10.0		
0.0049	10.6		
0.0044	11.1		
0.0038	11.7		Add to Sp.Gr. over 15.5°C.
0.0033	12.2		
0.0027	12.8		
0.0022	13.3		
0.0016	13.9		
0.0011	14.4		
0.0005	15.0		
0.0004	15.6		
		16.1	0.0006
		16.7	0.0012
		17.2	0.0017
		17.8	0.0023
		18.3	0.0028
		18.9	0.0034
		19.4	0.0039
		20.0	0.0045
		20.6	0.0051
Subtract from Sp.Gr. below 15.5°C.		21.1	0.0056
		21.7	0.0062
		22.2	0.0067
		22.8	0.0073
		23.3	0.0078
		23.9	0.0084
		24.4	0.0089
		25.0	0.0095
		25.6	0.0101
		26.1	0.0106
		26.7	0.0112
		27.2	0.0117
		27.8	0.0123
		28.3	0.0128

was stopped and the rubber allowed ½ hour to settle. The "J" shaped pipe was screwed into the suction line and the resin-laden solvent pumped into the acetone-gasoline-resin tank, where it remained until ready to purify. The churn was again filled with solvent and run for 1 hour, settled ½ hour, and pumped out as before into the acetone-gasoline-resin tank. The rubber was given two more treatments of either 1- or ½-hour duration with 15-minute settling periods between. The first and second treatments removed most of the resin. The third and fourth were largely diluting and purifying treatments and carried but little resin, so this solvent was used over again in the first and second treatments of the next charge.

After four lots of solvent had been pumped out, water was added in order to precipitate the rubber, and matt it together. The vent line was closed and the steam line opened. "Steaming off," as it was called, was continued until nothing but water or water with a thin film of oil appeared at the sight box, at which time the hydrometer reading rose to 1000. When this occurred, the charge was ready to be dropped. The large valve at the bottom was opened, the paddles reversed, and a stream of water played on the rubber through the manhole. The charge fell into a large zinc-lined box placed underneath the churn. After cooling sufficiently the rubber was taken out, washed with water on the washing rolls, and sheeted. Drying was accomplished by means of a vacuum dryer.

The schedule of treating was as follows:

First treatment	2 hr.
Settle	½ hr.
Pump Off	
Second treatment	1 hr.
Settle	½ hr.
Pump Off	
Third treatment	1 or ½ hr.
Settle	½ hr.
Pump Off	
Fourth treatment	1 or ½ hr.
Settle	½ hr.
Pump Off	
Steaming	4 to 5 hr.

The actual time per cycle was about 10 to 14 hours, because of the time required for pumping out the respective charges and for discharging. About four charges were handled with the three churns running the full 24 hours. Fig. 3 is a diagram of the operation of the process described above.

With 1200 pounds of Guayule as a charge, the mixed solvent required for the first treatment was 1800 gal-

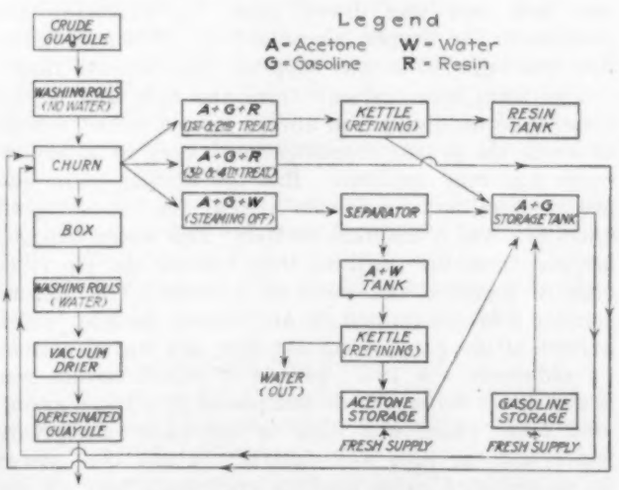


FIG. 3—CYCLE OF OPERATIONS

lons, and for all others about 1400 gallons, making about 13,000 gallons mixed solvent required per day. The solvent losses did not usually run over 44 gallons of gasoline and 15 gallons of acetone per 1000 pounds of rubber produced. With Guayule the yield of dry rubber was seldom more than 55 per cent of the weight of the charge. This was because the rubber was not washed and dried before deresinating. It was found more satisfactory to merely mill the gum until it was partly broken down and dry it by means of solvents.

The high washing loss of Guayule, about 20 per cent, was also a factor. The maximum daily output of deresinated rubber was about 2600 pounds.

In view of the large quantities of liquids required it is obvious that much depended upon the skill with which the plant superintendent refined his solvents. If he grew careless, he might lose enough to completely wipe out the profits. The liquor from the first and second treatments was pumped with the dissolved resin to the proper tank. From here it went to a kettle where the gasoline and acetone were distilled off and the condensate piped to its tank. The resin of Guayule, being fluid, was also pumped to a tank. The liquor from the third and fourth treatments, being fairly pure, was used in the first and second treatments on the next charge. The condensate from the steaming-off operation consists of gasoline, water, and acetone. This mixture was pumped to the separator and allowed to come to equilibrium. The top layer consisted of gasoline and acetone and the lower of acetone and water. The quantity of acetone in the gasoline depended upon the amount of water present. The acetone and water, and acetone and gasoline were carefully drawn off and piped to a separate container.

No attempt was made to separate the acetone from the gasoline in the acetone-gasoline mixture. This cannot be done by distillation since they form a minimum boiling point mixture. It can only be accomplished by adding sufficient water and allowing the gasoline to rise to the top. Separation of acetone from gasoline was unnecessary since it was much simpler to add either acetone or gasoline to bring the mixture to the correct proportions. The acetone-water mixture was fractionated in the kettle with the tall still head, which was kept running entirely on this work. The acetone thus obtained was piped into the acetone storage tank and was drawn upon for balancing the solution to the proper concentration. Whenever gasoline was required it was supplied from storage tank.

The resin-laden solvent from the first and second treatments on distillation always gave a mixed solvent of about the proper concentration. Very little adjustment was ever required. But the acetone-water and acetone-gasoline condensate from the steaming-off operation was a different matter. The water removed acetone from the gasoline, thus making the top layer rich in gasoline and poor in acetone. The acetone content was determined by an indirect method, which arrived at the gasoline content first and that of acetone by difference. A 10-cc. sample of mixed solvent was drawn from the separator and placed in a 15-cc. graduated tube, which was filled to the 15-cc. mark with water and the tube well shaken. It was then placed in an ordinary urine analysis centrifuge and whirled about a minute. The acetone-water solution was removed from the bottom of the tube by a pipette. This was repeated once more. Ten cc. of water were then added, mixed, and whirled again. The reading above the 10-cc. mark, that is the gasoline layer, readily gave the gasoline content. The percentage of acetone was obtained by difference. In order to make use of this mixed solvent, one had only to solve a simple algebraic problem: Given a certain volume of mixed solvent V consisting solely of acetone and gasoline; let the percentage (by volume) of acetone in the mixture be a which is determined; required (case 1) the quantity x (in gallons) of acetone to be added when the mixture contains less than 53 per cent acetone and (case 2) the quantity y of gasoline required when the acetone content is greater than 53 per cent.

Case 1.

$$aV + x = .53(V + x)$$
$$= .53V + .53x$$
$$.47x = .52V - aV$$
$$x = \frac{V(.53-a)}{.47}$$

Case 2.

$$(1-a)V + V = .47(V + y)$$
$$= .47V + .47y$$
$$.53y = .47V - V + aV$$
$$= aV - .53V$$
$$y = \frac{V(a-.53)}{.53}$$

Obviously the shift foreman of a deresinating plant could not stop to work out each separate problem, so his requirements were estimated beforehand and the quantities are recorded in Table IV.

The successful operation of a deresinating plant calls for eternal vigilance on the part not only of the foremen and superintendent but of every one concerned. All lines, tanks, kettles, condensers, etc., should be plainly numbered and a chart framed in a convenient place where the operation going on in any one is clearly indicated. All valves should have "open" and "closed" signs, and the purpose of each one clearly indicated by a tag wired to the wheel. A good rule is to keep all valves closed when not in use. The operation as above outlined is far from foolproof and a careless man can destroy a month's profit by one thoughtless act. Leaks of all kinds are to be very carefully watched for. The solvent loss is plenty high enough under the best of conditions without being increased by leaks. The greatest foe of succesful operation is carelessness, of which the following is an example. A certain plant did not show a profit over a whole year, notwithstanding the fact that it was running at maximum capacity and apparently as efficiently as possible. Upon investigation it was found that through a mistaken idea on the part of a laborer they were sending about 1000 gallons of acetone each month into the sewer.

TABLE IV.

Per Cent Acetone	Gallons	Gallons Mixed Solvent														
	30	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800
		Gallons Acetone to Add														
30		49	73	98	122	147	171	195	220	244	269	293	317	342	366	391
31		47	70	94	117	140	164	187	211	234	256	281	304	330	352	376
32		45	67	87	112	134	156	178	201	223	245	268	290	320	335	357
33		43	64	85	106	128	149	170	192	213	234	256	277	320	341	362
34		40	61	81	101	121	141	162	182	202	222	242	263	283	303	323
35		38	58	77	96	115	134	154	173	192	211	230	250	269	288	307
36		36	54	70	91	108	127	145	163	181	199	217	235	253	272	290
37		34	51	68	85	102	119	136	153	170	187	204	221	238	255	273
38		32	48	64	80	96	111	127	143	159	175	191	207	223	238	255
39		30	45	59	74	89	104	119	133	148	163	178	193	208	222	237
40		28	41	55	69	83	97	110	124	138	152	166	179	193	206	220
41		26	39	52	66	79	92	105	119	131	144	157	170	183	197	210
42		23	35	47	59	70	82	94	106	117	129	140	152	164	176	187
43		21	32	42	53	64	74	85	95	106	117	127	138	148	159	170
44		19	29	38	48	57	67	76	86	95	105	114	124	133	143	152
45		17	26	34	43	51	60	68	77	85	94	102	111	119	128	136
46		15	22	30	37	45	57	59	67	74	82	89	96	104	111	118
47		13	19	25	32	38	44	51	57	63	69	76	72	77	95	101
48		11	16	21	27	32	37	42	48	53	58	64	69	74	80	85
49		9	13	17	21	26	30	34	39	43	47	52	56	60	64	69
50		7	11	14	18	21	25	28	31	35	39	42	46	49	53	56
51		4	7	9	11	13	15	18	20	21	23	26	28	30	32	34
52		2	3	4	5	7	8	9	10	11	12	13	14	15	16	18
53		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		Gallons Gasoline to Add														
54		2	3	4	5	5	6	7	8	9	10	11	12	13	14	14
55		4	6	8	10	11	13	15	17	19	21	23	25	27	29	30
56		6	8	11	14	17	20	22	25	28	31	34	36	39	42	45
57		8	11	15	19	23	27	30	34	38	42	46	48	53	56	60
58		9	14	19	24	28	38	38	42	47	52	56	61	66	71	76
59		11	17	23	28	34	40	46	51	57	63	68	74	80	85	91
60		13	20	26	33	40	46	53	59	66	73	79	86	92	99	106
61		15	23	30	38	45	53	60	68	75	83	90	98	105	113	120
62		17	26	34	42	51	60	68	77	85	94	102	111	119	128	136
63		19	28	38	47	57	66	76	85	95	104	114	123	133	142	152
64		21	31	42	52	62	73	83	94	104	114	125	135	146	156	166
65		23	34	45	57	68	79	90	102	115	124	136	147	158	170	181
66		25	37	49	61	74	86	98	111	123	135	148	160	172	184	197
67		26	40	53	66	79	92	106	119	132	145	158	172	185	198	211
68		28	42	56	71	85	99	113	127	141	155	169	183	197	212	226
69		30	45	60	75	90	105	120	135	150	165	180	195	210	225	240
70		32	48	64	80	96	112	128	144	160	176	192	208	224	240	256

Improvements

Churns. These were about as efficient as can be expected of any intermittent process. Personally, I prefer continuous counter-current extraction, pumping the solvent from churn to churn. During steaming off there was a tendency for rubber to be carried into the condenser. Later this was prevented by installing a trap. Steaming off was not entirely a harmless operation. The heating brought about more or less depolymerization of the rubber, but at that time it was necessary in order to remove all the solvent. Vacuum distillation at a low temperature would give a much better product without the trouble of foaming.

Kettles. The kettles would have been more efficient if they had been steam jacketed around the sides. There was often a tendency to foam, which was particularly noticeable with Palembang. The use here of one of the modern kettles would greatly aid the efficiency of the plant. A vacuum kettle might help.

Condensers. The condensers functioned fairly well as long as there was plenty of cold water. The acetone still should have had a larger condenser, since there was hardly enough cooling surface to condense all the vapor when the still was working at maximum capacity.

Recovery Tower. The recovery tower was really a make-shift intended to catch uncondensed acetone, which unfortunately was no small amount. Its efficiency would be improved by filling the tower with any standard tower packing, thus increasing the surface.

Separator. Instead of the gravity separator described above, a centrifuge could be used to advantage.

Any chemical engineer can now suggest a number of sensible improvements. Deresinating practice will likely be almost entirely revised in the next few years.

Uses of Resins

Because of the scarcity of Ponti and related rubbers, their treatment was not given any particular discussion above. However, Ponti resin has certain uses. Being unsaponifiable it makes an ideal varnish for concrete. Pontiniack rubber and resin have been used in chewing gum. The products formed by dry distilling the resin are useful as a rubber substitute in cheap stocks.

Guayule resin is hard to dispose of, but is of value when added in small amounts to cheap stocks containing dry shoddies where its effect is that of a softener.

Conclusion

The purpose of the writer in preparing this paper has been to set forth something of our knowledge of rubber resins and to revive interest in deresinating, which is now almost a lost art. In view of our efforts in the war the deresination of Guayule will no doubt be resumed within a short time.

Current prices in platinum are no indication of its former value. At one time the crude grains mixed in with the ore of certain gold mines in Colombia, South America, were regarded as a waste product and thrown away. The extent of recovery of this metal may be store, recovering enough platinum to enable him to instanced by the case of one man who tore down his rebuild on a larger scale, and clear $4,000 in American gold besides.

Regulations Governing the Sale and Exportation of Caustic Soda

The U. S. War Industries Board and the War Trade Board jointly announce that on and after August 1, 1918, manufacturers of caustic soda in the United States will not enter into any contract for the sale of caustic soda with any person in the United States for the purpose of exporting the same, unless and until advised by the prospective purchaser that a United States export license covering such caustic soda has been duly obtained and the number thereof is furnished.

Manufacturers will not sell on and after the above mentioned date, caustic soda for domestic consumption unless the purchaser agrees not to export same nor to sell same for export, and if it is resold in the domestic market, to exact or cause to be exacted a similar agreement from each and every subsequent purchaser.

On and after August 1, 1918 the War Trade Board will not license for exportation caustic soda to any destination until the applicant complies with regulations contained in Ruling 175, copies of which can be obtained on application to any branch office of the War Trade Board.

Patent Office Needs Technically Trained Persons

The Commissioner of Patents, Washington, D. C., announces the need of technically trained persons for the examining corps of the Patent Office. Men or women are desired who have a scientific education, particularly in higher mathematics, chemistry, physics, and French or German, and who are not subject to the draft for military service. Engineering or teaching experience in addition to the above is valued. The entrance salary is $1500.

Examinations for the position of assistant examiner are held frequently by the Civil Service Commission at many points in the United States. One is announced for Aug. 21 and 22, 1918. Details of the examination, places of holding the same, etc., may be had upon application to the Civil Service Commission, Washington, D. C., or to the patent office.

Should the necessity therefor arise temporary appointments of qualified persons may be made pending their taking the Civil Service examination. Application for such appointment should be made to this office.

Combustion Engineers Wanted

The Bureau of Oil Conservation, Oil Division, U. S. Fuel Administration, desires to secure a combustion engineer for each of the districts named below, who will act as inspector of all plants within the district using fuel oil and natural gas: Boston, Providence, New York City, Philadelphia, Pittsburgh, Buffalo, Detroit, Chicago, Minneapolis, Tulsa, New Orleans and San Francisco. It is desired that these men shall act as volunteers. The Administration will pay a reasonable compensation for men who cannot give their services for nothing. Only those who have had experience in the combustion of fuel oil and natural gas would be of value to the Administration. Application can be made to W. Champlain Robinson, Director of Oil Conservation, Oil Division, United States Fuel Administration, Washington, D. C.

Recent Chemical and Metallurgical Patents

Manganese Dioxide Depolarizer.—In the preparation of a depolarizer with good electrical conducting qualities suited for use in dry batteries, MESSRS. CARLETON ELLIS and ALFRED A. WELLS of Montclair, N. J. (assignee, National Carbon Co.) patent the process of oxidation of manganese sulphate or chloride with hypochlorite in weak acid solutions at boiling temperatures. In strongly acid solutions, very little precipitate is obtained and in alkaline, the manganese is precipitated as brown manganic hydroxide and thus rendered unreactive with the free oxygen of the hypochlorite. When the sulphates are used, an excess of acid soon accumulates, which retards the reaction in proportion to its concentration; this excess acid is neutralized with sodium carbonate or basic manganese salts. In the case of the chloride salts, hydrochloric acid is volatilized to such an extent that either some of it must be condensed and returned to the solution or a slight amount of sulphuric acid or manganese sulphate must be added to maintain permanent acidity. With from ¼ to ½ per cent acid content, a quantitative yield is claimed with a mixture of 10 volumes of 44 per cent manganese chloride, 25 volumes of 30 per cent sodium hypochlorite, 11 volumes of 10 per cent hydrochloric acid, and 9 volumes of water. (1,269,914, 1,269,915; June 18, 1918.)

Aluminium Chloride.—The price of aluminium chloride has been relatively high due to difficulties in getting suitable materials for furnace construction resistant both to high temperatures, carbon and chlorine. On this account, it has been more economical to burn high priced metallic aluminium in chlorine gas than to use a crude source of material such as bauxite.

MESSRS. GEORGE H. KING and GERALD I. ROBERTS of Port Arthur, Texas (assignee, Gulf Refining Company) patent the process of passing a finely ground mixture of carbon and alumina, which has been heated to a very high temperature in a separate furnace, through an atmosphere of chlorine. The reaction,

$$3C + Al_2O_3 + 3Cl_2 = Al_2Cl_6 + 3CO$$

takes place with a maximum surface of reaction; dust impurities are removed mechanically before the aluminium chloride has condensed. Spent oil catalyst can be regenerated by this process, the product being oiled with kerosene to prevent hydrolysis with atmospheric moisture during the grinding process. (1,268,015; May 28, 1918.)

MESSRS. DILLON F. SMITH and HARRY ESSEX of Pittsburgh, Pa. (assignee, Gulf Refining Co.), patent the reaction between aluminium carbide, sulphide, etc., and chlorine or hydrochloric acid, which they state takes place as low as 200 deg. C. in an iron retort, the walls of which should be kept sufficiently cool to prevent the chlorine from reacting with the iron. (1,270,226; June 18,1918.)

Silica Fuse Filler.—For the manufacture of a silica powder of low apparent gravity, weighing from 12 to 30 pounds per cubic foot, MESSRS. W. C. ARSEM and J. G. E. WRIGHT of Schenectady, N. Y. (assignee, General Electric Company), patent the process of adding one part of 1.45 sp.gr. water glass to three parts of water and mixing with a solution of one part of ammonia chloride in eight parts of water, whereupon colloidal silica is precipitated in a very fine state having the approximate composition of $SiO_2.NH_3.H_2O$. The ammonia and water are removed from this precipitate by prolonged boiling and calcination of the filtered and washed hydrated silica.

Manufacture of Ammonium Phosphates.—INGENUIN HECHENBLEICKNER of Charlotte, North Carolina, has discovered that for the production of mono and di-ammonium phosphate the best concentration of phosphoric acid is from 35 to 43 per cent P_2O_5, the actual optimum varying with the purity of the acid and the heat insulation and the size of the apparatus. Fig. 4 shows this acid in tank 1, from whence it is distributed and trickles down the filling of tower 4, there absorbing a counter current of hot ammonia gas entering the system at 16. The resulting phosphate is further warmed by the considerable heat evolution of the reaction, and trickles through pipe 5 into the tube 7. Any remaining acid is neutralized by the ex-

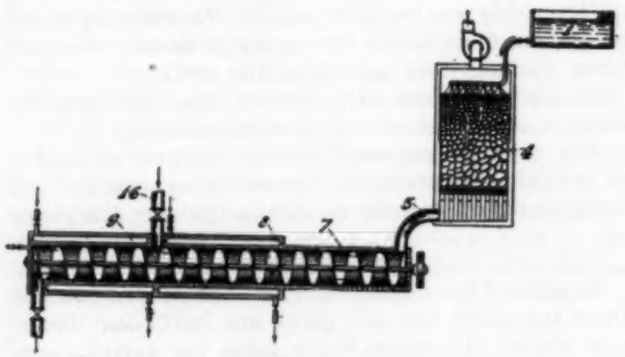


FIG. 1.

cess ammonia at this point, and crystallization starts immediately. The mixture is further dried by the steam jackets 8 and 9. The result is that in one continuous operation the inventor is enabled to produce moon and di-ammonium phosphate of a fine, dry, crystalline nature, stable and non-hygroscopic. In some cases the crystallizing tube may be replaced by a tank of water where the salts crystallize and are removed from time to time, centrifuged and steam dried if necessary. When di-ammonium phosphate is to be produced the solution in the saturation tank should be saturated hot until it has a slight ammonia odor. Di-ammonium phosphate is less soluble in hot water than in cold water and furthermore hot precipitation prevents the formation of tri-ammonium phosphate and gives a continuous crystallization of pure di-ammonium phosphate producing a fine, crystallized, stable, non-hygroscopic product. (Assigned to Southern Electro-Chemical Co., 1,264,513 and 14, Apr. 30, 1918.)

Operation and repair of Kjellin Refining Furnace.—DAVID R. KNAPP, of Pottsville, Pa., patents a device whereby the ordinary Kjellin furnace is placed on a circular plate capable of receiving a slight tilt, and

being slowly rotated simultaneously. In operation, the furnace is kept on a level keel at a normal temperature for the elimination of silicon and phosphorous. When these impurities are sufficiently reduced, the base plate is slightly tilted, thus contracting the area of the molten conductor at the high side. The metal at this point is therefore highly superheated with practically the normal power input; rotating the base plate changes the location of the superheated metal continuously, and the refining of the sulphur, manganese and carbon is thus effected. After tapping, the furnace may again be tilted to collect the molten conducting ring at the lower portions of the channels, when the entire furnace bottom may be inspected and repaired before proceeding with the next charge. (1,240,460; Sept. 18, 1917.

Alloy for Electric Resistance Elements.— The ohmic effect of titanium in alloy compositions is the basis of a patent by WILBUR B. DRIVER of East Orange, N. J. Mr. Driver gives the following list of alloy compositions with the determination of the specific resistance for each:

	Percentage Composition					
	Nickel	Chromium	Titanium	Iron	Manganese	Specific Resistance
No. 1	75	..	6	19	..	77
No. 2	68	15	4	11	2	117
No. 3	65	..	8	27	..	96
No. 4	65	..	6	19	10	106
No. 5	60	12	1	24	3	112
No. 6	60	12	6	19	3	125
No. 7	40	15	6	39	..	112
No. 8	30	10	6	54	..	117
No. 9	30	..	6	64	..	100
	Copper					
No. 10	80	10	3	..	7	48
No. 11	75	..	8	..	17	57
No. 12	45	45	3	..	7	77
No. 13	94	..	5	1	..	32

The advantages of these alloys are high melting points, durability and resistance to oxidation at high temperatures. The amount of titanium that can be used is limited only by the mechanical properties desired for drawing into wire and rolling into bars. Pure titanium is not a commercial product and even were it available, it would have too high a melting point for direct alloying purposes. Nickel-titanium and ferro-titanium are the present sources of supply. Owing to the relatively low specific gravity of titanium, it has a tendency to float, so that care should be exerted to entirely submerge it into the molten metals of the alloy. (July 30, 1918.)

Ammonia Sulphate.—A method of air oxidation of ammonia sulphite is patented by MESSRS HEINRICH DANNEEL and EMIL KUHN of Basel, Switzerland. The feature of their process is that calcium sulphite is formed according to the reaction:

$$(NH_4)_2SO_3 + CaSO_4 = (NH_4)_2SO_4 + CaSO_3,$$

and the sulphate is rapidly regenerated:

$$2CaSO_3 + O_2 = 2CaSO_4$$

In this way the loss of ammonia is prevented as well as the formation of an acid free ammonia. (1,274,247; July 30, 1918.)

Cleaning Metals.—When silver, gold, etc., are placed in an electrolyte in contact with an electro-positive metal such as zinc, aluminium, etc., nascent hydrogen forms on the silver under enormous pressure and either pushes off all foreign matter or reduces it, so that a clean metallic surface is produced. Sodium bicarbonate was used first probably because some woman accidentally dropped a silver spoon into an aluminium dish containing it, and discovered the "magic" way of cleaning silver. MESSRS. CHARLES B. MOREY and C. J. HUBER of Buffalo, N. Y., have found an improved electrolyte for this process in a slightly acidified solution of sodium chloride. Three per cent salt with one-tenth of one per cent hydrochloric acid is their preferred solution. The acid keeps the contact between the two metals clean besides furnishing more active ions. (1,274,186; July 30, 1918.)

Calcium Sulphite.—As an aid to the conservation of sulphur, MESSRS. HENRY HOWARD of Brookline and FRANK G. STANTIAL of Melrose, Mass., of the Merrimac Chemical Company, have developed a process for extracting sulphur dioxide from flue gases in the form of calcium sulphite, which can well be used as an intermediate for the manufacture of sulphite liquor for wood pulp manufacture. The flue gases are passed through sodium hydroxide solution, the SO_2 reacting with the carbonate formed and the solution being regenerated as follows

$$Na_2CO_3 + SO_2 = Na_2SO_3 + CO_2$$
$$Na_2SO_3 + Ca(OH)_2 = CaSO_3 \text{ (insol.)} + 2NaOH.$$

Gas with as low a content of SO_2 as 0.75 per cent has been successfully reduced to 0.10 per cent by this process. (1,271,899, July 9, 1918.)

Lead Arsenate.—The reaction between litharge and arsenic acid is greatly accelerated in the presence of hydrofluosilicic acid which dissolves the lead and thus furnishes an abundance of lead ions to react with the arsenate. The reactions are:

$$PbO + H_2SiF_6 = PbSiF_6 + H_2O$$
$$PbSiF_6 + H_2AsO_4 = PbHAlO_4 + H_2SiF_6.$$

MR. I. P. LIHME of Lakewood, Ohio, in his patent specification, states that as small an amount as 1/200 equivalent of H_2SiF_6 produces this reaction giving a soft, flaky, white precipitate that is admirably suited for insecticide spraying solutions. In the older methods of preparation, where arsenic acid acts directly on the solid litharge particles, the precipitate of lead arsenate forms a crust on the lead, which is a less efficient insecticide. (1,267,428; May 28.)

Calcium Carbide.—An improvement in the form of the carbon used in producing calcium carbide is patented by MR. ROBERT RUSSEL of Chicago, Ill., in which a 94 per cent fixed carbon hard pitch coke is thoroughly mixed with lime. Calcium carbide of ninety per cent purity is reported as obtained, which is a fraction better than the coal coke product. The acetylene gas obtained upon hydrolysis of this pitch carbide is free from many of the usual impurities, an important factor where this gas is to be used in the chemical synthesis of alcohol, acetic acid and acetone. (1,271,229, July 2, 1918.)

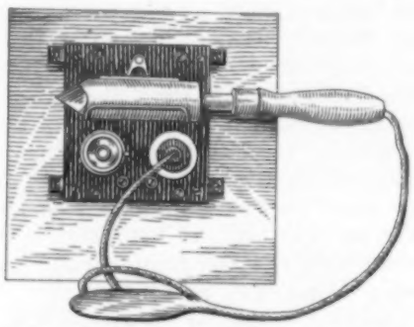
Sodium Hydrosulphite.—The reduction of sodium sulphite solution with hydrogen under high pressure as a substitute for zinc is patented by MR. A. K. GYUANDER of Westbrook, Maine. The reaction is simple:

$$2Na_2SO_3 + H_2 = Na_2S_2O_4 + 2NaOH.$$

It is found that the velocity of the reduction varies with the pressure of the hydrogen, 100 lbs. per sq.in. pressure bringing about a 95 per cent conversion in 352 hours; 1456 lb., 24 hours, etc. (1,270,150, June 18, 1918.)

Automatic Soldering Iron Rack

THE Cutler-Hammer Manufacturing Co. of Milwaukee have recently developed an automatic soldering iron rack and temperature control panel which decreases the amount of current taken by the iron while maintaining the working temperature. The rack consists of a small slate panel arranged for mounting and carrying a support for the soldering iron, which turns the elec-



tric current through a resistance circuit when weighted down. Taking the weight of the iron from the hook disconnects the resistance from the circuit and allows the full current to flow. A push button snap switch gives a convenient way of turning the current off and on without removing the soldering iron plug from the panel.

The Thomas Gas Meter

IN THE present day of fuel conservation, bee-hive coke ovens are passing out and to a great extent coke gas is coming into use. In view of this, the Thomas meters manufactured by the Cutler Hammer Co, of Milwaukee, with a capacity of 500,000 cu. ft. per hour,

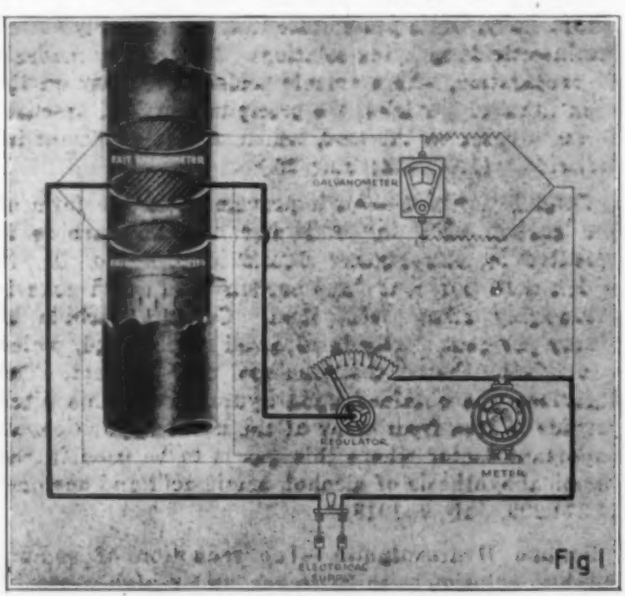


Fig 1

are an extremely interesting development. They embody the principle that, with a constant gas mixture, the specific heat is a function of its trade measurements. In the accompanying illustration Fig. 1 a sectional view of the gas main shows the arrangement of the electric resistance heating coils and the thermocouples. A differential of 2 deg. F. is maintained by means of the galvanometer control. The heat required to maintain this temperature is measured by the current consumed through the watt meter, illustrated in Fig. 3, which, however, is graduated to 1000 cu. ft. of gas. A graph

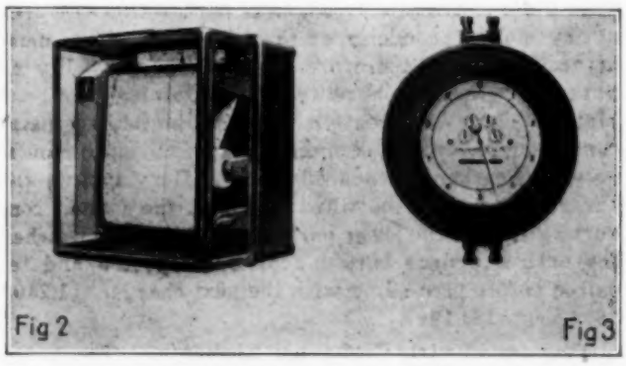


Fig 2 Fig 3

meter is also placed in the circuit, giving a time record of the rates of gas flow, Fig. 2. Daily gas analyses are made to check any variation in specific heat due to varying contents of hydrogen, methane, carbon monoxide, etc., and it is reported that no serious error arises from this source.

Electrical Controlling Pyrometer

THE most precise electrical measurements are those made by a zero or balance method, such as the Wheatstone bridge and the potentiometer. In both no current flows through the galvanometer at the moment when the measurement is made and hence galvanometer errors are excluded. In the potentiometer, variations in the resistance of lead wires and of the source of electromotive force, such as a thermocouple, are also eliminated, the lead wires and thermocouple being in the same circuit with the galvanometer.

Zero methods, however, require external power for the balancing of the circuit. For single measurements this power is ordinarily supplied by the hand; a contact is moved along a slide wire or resistances are plugged in or out until the galvanometer comes to the zero position, when the quantity to be measured is at once known from the amount of resistance that has been used. The Leeds & Northrup Co., of Philadelphia has developed a line of power-driven recorders, however, in which the adjustments are made automatically, the galvanometer merely determining in which direction the adjustment is to be made.

Early attempts to use a galvanometer for this purpose were along the line of having the boom or pointer of the galvanometer close an electrical circuit. This, however, proved unsatisfactory, as with low voltages on the boom, contact would not be made through particles of dust, while with a higher voltage the boom would "freeze" or fuse to the contactor. In the Leeds & Northrup apparatus the boom serves merely as a mechanical trigger. A reciprocating part, kept in constant motion by a motor, is arranged not to strike the boom when the latter stands in the no-current position, but when the boom moves out of this position in either direction, the reciprocating part pushes it against another part which adjusts the bridge or potentiometer circuit, the amount of the adjustment being regulated according to the distance which the boom has swung, that is, to the unbalancing current through the galvanometer.

The power of the motor is sufficient, not only for making the adjustments, but also for the operation of the chart drum or roll. For this purpose, however, the motor must run at a constant speed, that is, sufficiently constant to give good time-keeping qualities, since the abscissae of the chart are laid off in hours and minutes. This has been found to necessitate the use of a special

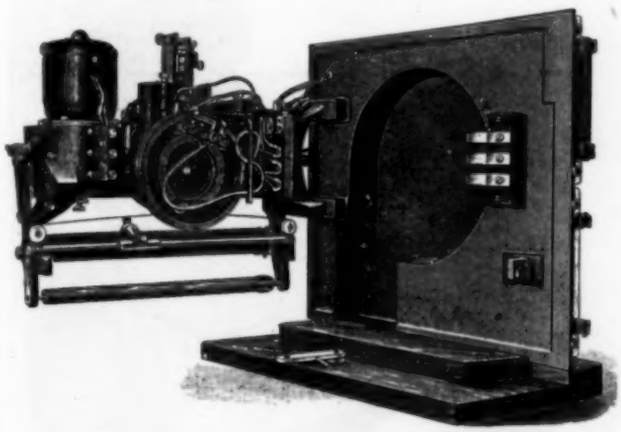


FIG. 1.—RECORDER OPEN FOR EXAMINATION

governor, and much time and research have been devoted to this problem. The governor finally adopted is of the centrifugal type and operates by opening and closing a shunt in the field circuit. When the motor is in operation this contact is continually on the make and break, as may be easily detected by listening to a telephone receiver connected in the circuit.

The motor not only adjusts the movable contact of the bridge or potentiometer, but also supplies power to move the recording pen. Multiple recording instruments which will record for a number of different thermocouples or resistance thermometers are also built. In these the motor operates the selector switch which connects the recorder to the different circuits and simultaneously turns a printing wheel which impresses upon the record sheet a dot to record the reading, and a number to identify the circuit which is being measured.

In the heat treatment of metals, it is becoming more and more the practice to bring the leads from thermocouples in different parts of the furnace and in different furnaces to a central control station. This is facilitated by the introduction of base metal thermocouples, which permits of the prolongation of the couple itself to the measuring instrument, where the effects of temperature upon the cold end of the couple are readily compensated for, and by the adoption of the potentiometer method of measurement, with which differences in resistance of lead wires become immaterial. An attendant at the control station uses an indicating instrument, which he connects successively to different thermocouples. Usually he is also provided with switches, by means of which he can light signal lamps for the guidance of the operators at the furnaces, usually a red light to indicate too high a temperature, a blue one to indicate too low a temperature and a white one to indicate the right temperature. A multiple-point recorder is generally installed to record the different temperatures automatically, one after the other. The Leeds & Northrup Multiple Recording Instruments, for example, are built for as many as 16 different circuits.

Where it is preferred to have the signaling at the furnace done automatically, a Leeds & Northrup "single-point" or curve-drawing recorder is provided with contacts on the moving element by means of which the signal lamps will be lit, accordingly as the temperatures in the furnace are too high, too low, or correct. An interesting extension of this plan is to use two thermocouples in different parts of the furnace and to provide the recorder with a commutator by means of which it reads first on one and then on the other. The chart produced is a single line running alternately back and forth between the two temperatures and indicating the temperature difference graphically. At the same time the commutator controls a fourth signal lamp at the furnace to show which thermocouple is being measured.

The double recorder is thus suitable for demonstrating uniformity of furnace temperatures, or the lack of it. It shows graphically the effects of empty furnace, full furnace, or part full furnace, and how distribution of heat is affected by rates of firing, location of load, door and other losses, cold hearth, etc. It is a convenient means for investigating furnaces and showing how errors may be overcome by moving burners, baffles, or arches, or changing the method of introducing heat, as by the use of side burners, underfiring, overfiring, number of burners, position of doors, etc. It also shows definitely the effects of location of thermocouples, how the readings vary according to their placing with respect to the work and the burners, also the number of couples to be used in a given furnace, etc.

The use of this double recorder has exploded the old "soaking heat" idea, since it demonstrates that it is practically impossible to bring many kinds of loads up uniformly to the desired temperature by holding the

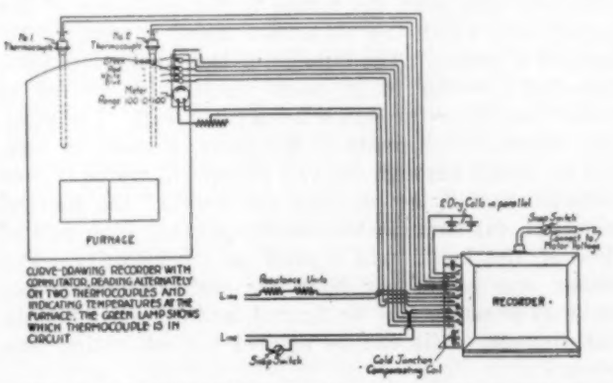


FIG. 2.—INSTALLATION WITH TWO THERMOCOUPLES

furnace at a "constant" temperature, without underheating some parts, and overheating others. This type of equipment has been found of especial value in studying the heating of different kinds and sizes of sections or numbers of pieces, different methods of loading, speed of loading and unloading, mechanical furnacing, the heat treatment of large single pieces, such as gun forgings, etc.

Atomizing Nozzle

IN THE mixing of corrosive chemicals, which must be brought together slowly because of their heat of reaction, etc., such as in nitrating, unsaturated coal-tar oils,

sulphur-chloriding oils for making rubber substitutes, etc., a recently developed stoneware nozzle placed on the market by the Monarch Manufacturing Works of 3129 Emery St., Philadelphia, Pa., will find a ready demand. As shown in the accompanying illustration, the upper part is a metal socket of lead or any desired metal or material for attaching the nozzle to the conductor of the liquid, into which the stoneware nozzle screws tightly against a gasket. The outside of the nozzle is conical, insuring a wedge fit in cases where it is desired to induct the spray through a terra cotta wall. The gyratory action, which produces the spray, is made by forcing the liquid through the two grooves *G*, which is then reflected radially by striking the walls of the enerical recess *R*, out through the nozzle opening. The rate of flow of the liquid will depend on its viscosity. For water, one gallon per hour for each 10 pounds per sq.in. of pressure may be figured, and for other liquids, the viscosity ratio can be applied for estimating purposes.

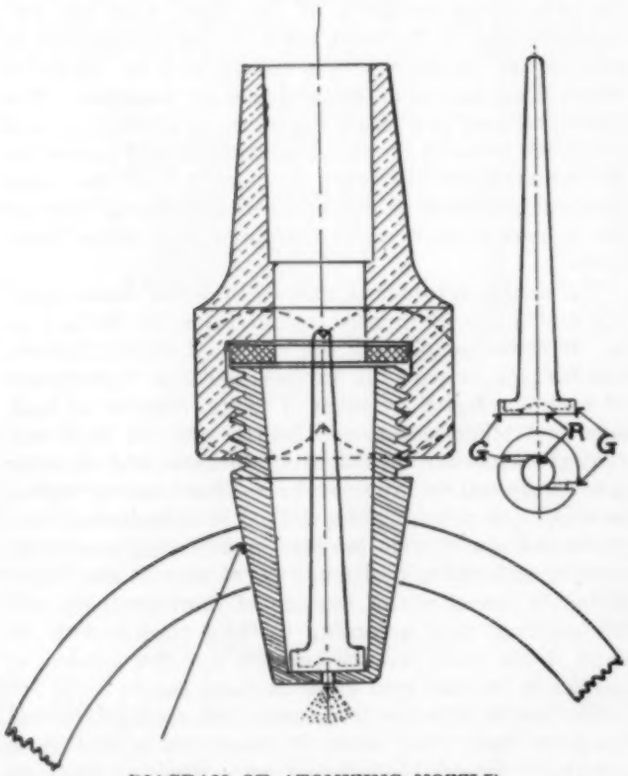
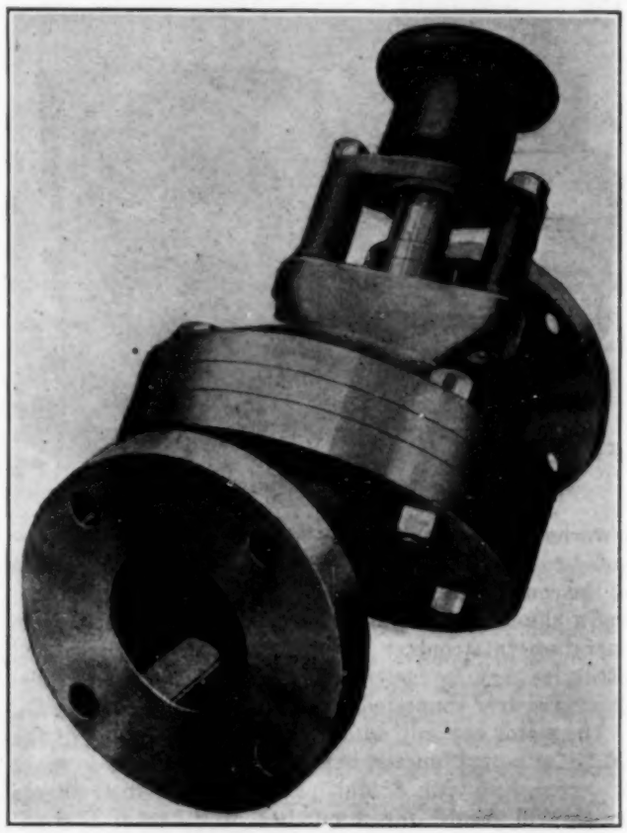


DIAGRAM OF ATOMIZING NOZZLE

Valves for Corrosive Liquors

THE weakest point in any valve, and especially in one for corrosive liquids, is the valve seat. The lead valves manufactured by the Chemical Equipment Company, Chicago Heights, Ill., have a double faced seat, which can be taken out, reversed or redressed without dismounting the valve body. The seat is provided with a straight cylindrical hole in the center and the tapered plug meets this in a single line contact. A feature of the line contact on a tapered plug is that, should there be a scale formation on the plug, the act of seating will crack off the scale and give a tight closure.

Lead being a comparatively soft metal, it is essential that provision be made to prevent the turning of the valve stem at the time of seating, a requirement provided for in this valve which insures a uniformly wearing plug and seat. The threads for operation are in a grease-packed casing in the handle. The valve can be packed under pressure, as a packing gland is adjusted by means of a sleeve operating within the upper part of the yoke, the threads of which are grease packed.



VALVE FOR CORROSIVE LIQUORS

GENERAL DATA ON LEAD VALVES

Size	1½ in.	2 in.
Face to face of flanges	8½ "	10 "
Diameter of flanges	4½ "	5½ "
Diameter of bolt circle	3⅛ "	4¼ "
Number of bolts	4 "	4 "
Diameter of bolts	¾ "	¾ "
Approximate weight	58 lbs.	62 lbs.

Gas Rivet Heaters

Gas is to be used exclusively for rivet heating, plate bending and general fabricating heating purposes hereafter at the Bethlehem Shipbuilding Corporation's Alameda plant. This is a radical departure from the shipbuilding methods that have been in use for years, whereby it was thought that only coke could be used—even oil was considered an innovation. Good work by a riveting crew depends to a great extent on properly heated rivets. With a continuous and uniform gas forge, the heater man can give his undivided attention to regulating the forge so that there will be no burned nor underheated rivets, irrespective of the speed at which the crew works. This tends toward regularity, with properly upset and tight, full-headed rivets as a result. The cooling contraction is likewise more uniform and caulking is reduced to a minimum.

Synopsis of Recent Chemical and Metallurgical Literature

Combustion of Producer Gas.—V. HASSREDTER, in *Metall. und Erz.* Vol. XV, page 139, gives calculation formulæ for the excess of air used in combustion of producer gas. When a volume, G of producer gas is burned, the volume of air, L, required is not $R - G$ as commonly stated, but $R - G + c - d$, where R is the volume of products of combustion, c the contraction and d the contraction due to combustion. For each volume of each of the following gases, when dry, the respective values of c are: C_2H_4 or C_6H_6, 2.5; CH_4 or C_2H_6, 2.0; H_2 or C_2H_2, 1.5; CO, 0.5. When the volume of the moist products of combustion is taken, neither expansion nor contraction occurs in the combustion of methane and ethylene; hydrogen and acetylene contract 0.5 vol.; but with ethane and benzene, expansion ($d = .5$) occurs. If L_o = the volume of air theoretically necessary, and L = the excess of air admitted, $L_o = R - L - G + c - d$. This equation is applicable to moist flue gases if the volume of the water-vapor in them is taken into consideration. On the customary assumption that $L = R - G$, the ratio $\frac{L}{L_o}$ may have only half its proper value. If E = the percentage of air in excess of that theoretiucts of combustion, X = volume of oxygen theoretically cally necessary, x = the excess of oxygen in the prodrequired for the combustion, and R = the volume of products of combustion, $E = \frac{100\,Rx}{X}$. Fischer's ratio, $\frac{21}{21 - 79\frac{o}{n}}$: 1 (where o = per cent of oxygen and n = per cent of nitrogen in the products of combustion), is applicable to coal, coke and illuminating gas, but not to producer gas and other fuels containing a considerable percentage of nitrogen. Furthermore, use of the percentage of nitrogen in the products of combustion as a basis for calculating the excess of air present is unsatisfactory, since a variation of 10 per cent in the latter causes a variation of only 0.1 per cent in the nitrogen, but a variation of 8 per cent in the free oxygen.

"The Estimation of Tin in High-Grade Wolframite and the Use of Lead as a Reducing Agent in Pearce's Assay" was the subject of a paper read by A. R. POWELL at the June meeting of the London section of The Society of Chemical Industry.[1] Four methods were discussed for the quantitative separation of small quantities of tin from rich tungsten ores, two of which were devised by the author. In the older methods the ore was boiled with aqua regia, the insoluble stannic and tungstic oxides filtered and extracted with ammonia, the residual stannic oxide being fused with sodium peroxide and the assay continued in the usual way; or the ore may be fused with cyanide and the ferro-stannic residue dissolved in hydrochloric acid and the solution reduced and titrated.

The author's first method consists of fusing the ore with sodium peroxide and making the melt up to a known volume with water. An aliquot portion is filtered off and the tin separated either by boiling the solution with ammonium nitrate, or the alkaline solution is acidified with tartaric acid together with a slight amount of hydrochloric acid, then the tin is precipitated with hydrogen sulphide.

In the second method, the ore is fused in sodium acid sulphate and the melt boiled with tartaric acid, which dissolves everything except tin oxide and gangue; then the insoluble residue is filtered and fused in sodium peroxide. Copper, bismuth and molybdenum are removed by extracting the ore with nitric acid.

The author has found that stannic chloride solutions can be reduced satisfactorily by lead or zinc-lead instead of iron. it being unnecessary to remove the lead in order to titrate; moreover, the solution is colorless. This method is a rapid one, since sixteen to twenty assays can be made by it per hour.

Lignin from Sulphite Waste Liquors.—An article in *Svensk Pappers-Tidning* by MR. R. W. STREHLENERT gives an account of a process for the precipitation of the dissolved colloidal lignin. As there is practically a ton of organic matter carried away in the waste liquor to every ton of dry pulp made, five-eighths of which are lignin, one-fourth other carbohydrates, and the remainder resins and organic acids, the importance of recovering and utilization of this material is obvious. Klason has determined the molecular weight for lignin to be about 6000, which would indicate an approximate formula of $(C_{40}H_{42}O_{11})_8$. The lignin is in solution in the waste liquor as a calcium ligno-sulphonite salt. Strehlenert finds that at the critical temperature, at which SO_2 is given off by decomposition, oxygen rapidly acts on the sulphite ions giving sulphate ions, which form lime salts insoluble in the presence of excess SO_2 and thus break up the complex ligno-compounds. As the reaction, $3SO_2 \rightarrow 2SO_3 + S$, takes place under the conditions of temperature and pressure used, air is not essential for the decomposition (phenomenon called "black cook in papermaking") but a coarser precipitate is obtained with air oxidation, which is more easily filtered and dried. Strehlenert is using the dried filter cake for fuel at Gota, Norway. As coal is cheaper in America and labor more expensive than in Norway, it is doubtful whether lignin would be an economical fuel.

Discoloration of White Paint.—At a recent meeting of the Society of Chemical Industry at Birmingham, Eng.,[1] Dr. D. F. Twiss discussed the yellowing of white paints. Lead, zinc and barium pigments were found to be equally susceptible and the evidence indicated that the source of discoloration was not in the pigment but in the oil. When a little of the oil was separated from the paint and absorbed into paper free from mineral impurities, the dried film, on being kept in a warm place, was found to develop gradually a marked yellowish brown color. Bleached films were immediately disclosed by keeping in a warm place unexposed to actinic action and the discoloration and bleaching processes were repeated many times in succession, the tendency to discolor undergoing but slight diminution. Artists have found that walnut and poppy seed oils have less tendency to turn yellow, but for commercial work, linseed is the oil par excellence.

[1] *Journal of the Society of Chemical Industry*, XXXVII, 241 R.

[1] *Journal of the Society of Chemical Industry*, Vol. XXXVII, June 23, 1918, p. 179T.

Book Reviews

EDIBLE FATS AND OILS. By *C. Ainsworth Mitchell, B. A., F. I. C.* Pages, 159. Price, $2.00. New York and London: Longman, Green & Co.

This little volume is one of the Monographs on Industrial Chemistry, edited by Sir Edward Thorpe, C.B., LL.D., F. R. S.

As stated in the preface, it gives a "concise outline of the chemical composition and properties of the more important oils and fats, together with a description of the methods of extracting them from the crude material and of purifying them for food purposes."

Although the author has worked with the end in view of giving principles rather than working details of the various analytical processes mentioned, he has succeeded in a wonderfully small space in giving very full information regarding modern methods of oil and fat investigation, while the tables of constants and thirty-three pages of bibliography make it a valuable work of reference to the specialists.

The portion of the work dealing with manufacturing processes is little more than a sketch and is in no way to be considered as a guide to their application, but rather a source of general information.

The chapters on hydrogenation and margarine manufacture considered as short general outlines are particularly good, while a very complete index adds greatly to the value of the volume as a concise book of reference.

PETROLEUM, ASPHALT AND NATURAL GAS. By *Roy Cross.* Pages (5 x 7½), 212. Price $2.00. Kansas City, Missouri: Kansas City Testing Laboratory.

This little leather-bound volume is Bulletin No. 14 of the Kansas Testing Laboratory. It is very practical and well-nigh indispensable to petroleum and gas chemists, having statistics, physical, chemical and pneumatic tables and many illuminating features. The table on page 62-63 on "Horizontal Cylindrical Tank" segments should have had some explanatory remarks—and should have included spherical bumps and steam coil segments, besides referring to the published actual calibrations of tank cars by name and number. Twenty blank pages are reserved for notes facilitating additions to the volume.

THE ALKALI INDUSTRY. By *J. R. Partington.* Pages (demy octavo) 304. Price, $1.80. London: Baillière, Tindall & Cox.

The title of this book is not sufficiently inclusive since the author devotes over 60 per cent of its space to sulphuric and nitric acids, chlorine and iodine. The treatment of the salt industry, soda processes, electrolytic processes, ammonia, potash and magnesia is less elaborate than desirable, being too extensive for the general reader and of little practical value in training an alkali chemist. The many modern electrolytic cells are not even mentioned in the eight-page chapter on "Electrolytic Processes." In the contact process for the manufacture of sulphuric acid and the oxidation of ammonia to nitric acid, the reader will find an introduction to the great recent developments in this branch, but of course no complete accounts will be available under present international conditions.

Personal

MR. STUART B. MARSHALL, formerly manager of the American Manganese Manufacturing Co., Dunbar, Pa., and until recently general superintendent of the Aluminum Company of America's properties and business in North Carolina, at Badin, is now located at Roanoke, Va., as consulting engineering chemist and metallurgist for coal and ore lands, blast furnaces, manganese pyrites, antimony, lead and zinc deposits, ferromanganese and spiegel operations, minerals, etc.

MR. JOHN C. MERRILL is the successor to the firm of Sulliger and Merrill, located at 1400 Hibernian Building, Los Angeles, California.

PROFESSOR JULIUS STIEGLITZ, chairman of the department of chemistry at the University of Chicago, has been appointed special expert in the United States Public Health Service of the Treasury Department. This will not involve his work at the university. The government assigns him two assistants, who will be in the employ of the Public Health Service and will carry out their work in Kent Chemical Laboratory under Professor Stieglitz's direction.

MR. SAMUEL WIERMAN has resigned his position as chief chemist at the Citrus By-Products Company, Corona, California, to accept the position of chemist-in-charge of the Chemical and Agricultural Department of the Societé Financiere des Caoutchoucs of Antwerp, Belgium, and London, England. The scientific departments of the Societé are located in the Federated Malay States, convenient to their rubber plantations in the Malay States, Sumatra and Java.

Current Market Reports

Non-Ferrous Metal Market

Wednesday, August 7.—Prices have remained stationary during the past two weeks. Government price-fixing seems to have served as an antidote for speculating.

Aluminium:—The government prices on ingots are 33c. a pound f.o.b. plant in 50-ton lots, 33.1c. down to 15-ton lots and 33.2c. in lots down to 1 ton, which prices will be effective until September 1. Prices for small lots vary from 40c. to 45c.; sheet aluminium, 18 ga., and heavier, 42c.; powdered aluminium, $0.65 to $3.00 per pound, according to mesh.

Antimony:—The demand is very weak and spot duty paid has fallen in price, 13c. to 13¼c.

Chrome:—Large quantities of high-grade material have been sold at a premium, 50 per cent ore bringing $1.70 per unit.

Copper:—Government price fixed at 26c. for carload lots and 27.3c. for smaller quantities is expected to be changed on August 15. A conference is being held between the producers and the War Industries Board, and it is probable that no official increase in price will be allowed without considerable delay and presidential sanction.

Copper sheets, hot rolled	lb.	$0.36	—$0.37½
Copper sheets, cold rolled	lb.	.37	— .38½
Copper bottoms	lb.	.44	— .45½
Copper rods	lb.	.36	— .37
Copper wire	lb.	.29½	—
High brass wire	lb.	.28½	— .29½
High brass sheets	lb.	.28½	— .29½
High brass rods	lb.	.26½	— .28½
Low brass wire	lb.	.32½	— .34½
Low brass sheets	lb.	.32½	— .34½
Low brass rods	lb.	.33½	— .35½
Brazed brass tubing	lb.	.37	— .39
Brazed bronze tubing	lb.	.42½	— .44½
Seamless copper tubing	lb.	.41	— .43
Seamless bronze tubing	lb.	.45	— .46
Seamless brass tubing	lb.	.37½	— .39½
Bronze (gold) powder	lb.	1.00	— 1.75

Lead:—Demand strong with supplies scarce. War consumption has been exceptionally heavy. A limited quantity of prompt lead is quoted at 8½c. to 8¾c. September and October deliveries prices in New York, 8.05c. per lb.; East St. Louis, 7.75c. in 60,000-lb. lots; full sheet lead, 10c.; cut sheets, 10¼c.

Manganese:—Prices remain at $1.35 per unit basis.

Molybdenum:—Domestic demand still lacking. The price is nominally $1.00 per unit of 90 per cent MoS_2.

Spelter:—Spot delivery in New York is quoted at 8.5c. to 8.6c. for prime Western. East St. Louis, all positions to the end of the year range between 8.1c. and 8.2c. Sheet zinc is 15c. and zinc dust, 16c. to 20c. per pound in 1600-lb. barrels.

Tin:—Owing to river floods in China, transportation of tin there has been interrupted, with consequent advance in Singapore prices to 98½c. f.o.b. London. Open market in New York dull with prices varying between 92c. and $1.00. Babbitt metal varies between $1.10 and 70c. per pound. Solder 50-50, 73c.

Tungsten:—The British government has attempted to steady the tungsten industry by guaranteeing a price of 60 shillings a unit for the duration of the war and six months thereafter. The highest grade material, containing no tin, no copper and low manganese and over 70 per cent WO_3, is selling at $25.50 per unit. Lower grades vary between $20.00 and $24.00.

OTHER METALS

Bismuth	lb.	$3.50	—$3.65
Cadmium	lb.	1.50	—.....
Cobalt	lb.	2.50	— 3.50
Magnesium	lb.	1.75	— 2.00
Mercury	75 lb.	125.00	—.....
Mercury	lb.	1.95	—.....
Nickel	lb.	.40	— .43
Iridium	oz.	175.00	—.....
Palladium	oz.	135.00	—.....
Platinum	oz.	105.00	—.....
Silver	oz.	.99½	—.....

The Iron and Steel Market

Further regulations have been made by the War Industries Board for the distribution of steel, in addition to those summarized in last report. Jobbers, who were accorded a B-4 preference for the replacement of material, month by month, that had been shipped the previous month on priorities and preferences, are given special treatment as to mill shipments to them for August, this taking the place of the regular procedure, which becomes effective for September. For August the mills are permitted to ship jobbers an amount of material equal to the monthly average shipped during the first half of the year. In some finished steel branches, like wire products and pipe, the mills can do fairly well under these regulations, but in sheets, merchant bars and some other products it is represented that by the time higher preferences are provided for there will be little if any material left to take a Class B-4 rating.

What is called "automatic priority" is provided for many descriptions of steel, each use prescribed being given its particular priority, as AA-2, A-3, B-6, etc. The buyer, when placing his order, makes a formal endorsement on it, certifying the use to which the material is to be put and naming the degree of priority that is accorded by the regulations. Commercial buyers must make affidavit; representatives of the Government need not. While this arrangement as to "automatic priority" seems like a radical step, in essense it is but a natural development, in that the Priorities Division as it gained experience had developed certain rules for its guidance in determining the degree of priority, if any, and when the rules became sufficiently stabilized procedure under them was simply handed over to the buyers.

These priorities, in the present complicated form, must be regarded purely as expedient to meet an undesirable and, it is hoped, a temporary situation. After the priorities come the preferences, and then Class D material, for purposes that are given no recognition. Obviously there is no occasion for a priority order for a given description of material if there is a supply of it left for the preference list, and obviously it is highly undesirable that there should be none of such material for the preference list, not to mention Class D consumers. The priority order does not alter the conduct of a mill if it can make the desired delivery without. It is only when the delivery desired by the buyer cannot be made otherwise that the priority order operates. Hence if there is enough steel for all the priorities they disappear as a governing factor. Eventually, it is hoped, priorities will become purely a matter of form and the desired deliveries will be made without their influence being exerted. The War Industries Board reserves the right to modify the priorities produced by the automatic system, in any particular case, and of course many uses are not covered by the list and the steel for such uses will still be given individual priority orders by the board.

Steel Requirements

While in July the War Industries Board made the statement that the finished steel requirements for the second half of the year amounted to between 20,000,000 and 21,000,000 net tons, while output had never exceeded 16,500,000 net tons, in conferring subsequently with the Fuel Administration, as to supplies of bituminous coal for the steel industry, it stated that the requirements were 22,000,000 tons, so that it evidently had not given up hope of the industry being able to produce more than 16,500,000 tons. This hope is well founded. The rate of production in May and June was nearly if not quite 3,000,000 tons, while July has done almost as well, despite the season of the year, and gains on 3,000,000 tons a month are therefore to be expected for the fall months, with possibilities therefore of 18,000,000 to 19,000,000 tons for the half year.

Some details have been furnished the steel makers as to how the total for the half year is made up, and the statement has also been made that the requirements for the first half of 1919 promise to run 20,000,000 tons or more. The steel industry is disposed to take the schedule as correct, although there remains some doubt whether the various activities will really be able to operate at expected rates and use the steel within the periods prescribed.

All estimates are necessarily rough as in all activities the greatest pressure is being applied, and this pressure will naturally be more successful in producing results at some points than at others. No activity is being curbed to suit the pace of another activity. In shipbuilding there is the shipment of the steel, the fabricating at detached plants, the work on the shipways and the work in the fitting out basins, with a thousand things to be supplied the ship before it is completed. Theoretically, the Director of Shipbuilding would apply pressure where most needed but his conduct to date has been that of applying pressure everywhere, showing no favoritism. Boilers are the crying need when he talks to boiler makers, the driving of rivets when he talks to the shipyard workers, and so all along the line.

War Activities

There have been heavy lettings of shell contracts, involving a material increase in the rate of shell steel consumption. If the production of shell steel has not already exceeded a rate of 500,000 net tons a month it probably will do so in the near future. Since the first of the year there has been a large increase in the forging capacity for large shells, particularly 6-inch and larger, in which there was formerly a marked deficiency. With the demand running more largely to steel for large shells the burden upon the steel industry in the matter of rolling the steel is decreased, while the amount of steel subtracted from the supply to finishing departments in general is increased.

The plate allotment for shipbuilding in the United States is 50,000 net tons a week, or about 2,600,000 tons a year. Estimated production, including universal mill plates, is about 6,000,000 tons a year, nearly double the actual output of 1916, which represented approximately the existing capacity at the time. Further increases in plate production are in sight, through new construction, and by the end of the year there may be an increase of as much as 50,000 or 75,000 tons a month over the present rate. This heavy production of plates operates as does the heavy production of shell steel, to take raw steel out of the general situation and force finishing departments making less essential products, or products that are called for by war activities in smaller proportions, to operate at far below their capacity. Taking the rod mills, pipe mills, sheet mills and merchant bar mills as a whole, their operation is not over about 65 per cent of capacity.

New Construction Considered

This situation, coupled with the fact that the byproduct coking capacity has been increasing steadily and is marked for indefinite increase in future, as even in the past three months new plants have been projected, some with financial assistance by the Government, has led to an investigation of new construction as a means of providing more steel. It is readily seen that a fully integrated operation need not be constructed. There would probably be enough coke making capacity, if supplied with coal, also enough iron ore, at least for a time, and there would be enough finishing capacity,

if the present output of the finishing departments that are being operated at less than capacity is not sufficient for the war requirements, direct and indirect. Indications pointed strongly to the fact that additional blast furnaces and open-hearth furnaces, with perhaps an occasional blooming mill and slabbing mill, would increase the steel industry's capacity effective for war work. At the same time, viewed from the standpoint of the normal requirements of peace times, there would be left an excess of pig iron and steel making capacity. Accordingly the matter has been canvassed of the Government extending financial assistance in connection with the new construction, against which heavy amortization charges would have to be laid in view of the conditions. At the same time the influence of the War Industries Board would have to be invoked to provide the necessary man power and materials. To an extent yet to be determined, so far as is now known, this would be to the detriment of other war activities. Formal announcement of a decision on this matter may or may not be made in the near future.

STEEL PRICES

The very large profits and earnings being reported by steel companies indicate very clearly that there is no prospect of the War Industries Board advancing prices at any time. There may be some rearrangements of schedules, but no general advance is in prospect, and there may easily be horizontal reductions. The argument that some producers make much smaller profits than large producers has not been supported by citation of an adequate number of cases. The arguments are usually confined to generalities. Nor does the argument that wage advances increase cost of production and increased cost of production should be followed by advanced prices follow a logical sequence. The wage advances have as a rule been based upon the large earnings the employers were already enjoying.

Chemical Market

HEAVY CHEMICALS:—The market in general has not shown very great activity. Saccharine, both grades, has been on strong call with consequent appreciation in prices, but with regard to caustic there has been some uncertainty of just what might occur in view of the new Government regulations. Some discussion was raised also as to what might constitute a reasonable profit to dealers in sulphuric acid, but this has been dropped and business is continuing to be done at whatever the buyer is willing to pay.

Glycerine:—No definite confirmation has been received locally of the press dispatches from Washington concerning the so-called fixing of glycerine prices. Nevertheless, the trade is of the opinion that the matter has been definitely decided and that only an official anonuncement remains to be made. The prices are stated to be 60c., August-September; 58c. for October-November and 56c. for December. This of course is for dynamite glycerine. As we have before mentioned, the matter of a fixed price for dynamite glycerine was only a matter of time, although the War Industries Board has stated that they did not see the necessity of such a fixed price at the moment. However, the Food Administration thought otherwise and as it is known that the allied governments are about to purchase large quantities on this market the price fixing arrangement has at last materialized. There is practically no spot market at the present, although refiners express a willingness to sell at 60c. C.P. holds at 62c. The crude situation is much weaker and refiners claim purchases at 40c. loose for soap lye and 44c. for saponification.

Metabisulphite of Potash:—Prices asked for this material show a slightly advanced level due to the government taking the majority of the supplies available and very little being offered on the open market. Some lots are to be had but they are said to be small. Crystal material is held at from 1.20 to 1.40 with the powdered at from 1.10 to 1.20.

Metabisulphite of Soda:—This item has not been very active and prices quoted continue at about 30c. Large quantities, however, could be purchased at a lower figure, possibly 25c. in ton lots.

Sodium Sulphide:—Actual holders of spot lots of material are very hard to locate with the exception of one lot for immediate delivery at 8c. Prices are being quoted f.o.b. factory at 6.50, although a single sale was lately reported of material for September shipment at 2.00 advance over this figure.

Carbon Tetrachloride:—For a long time the Government requirements have been more than they were receiving, but leaving then but a small amount for the open market. It is understood that now not a pound can be distributed to consumers without first submitting questionnaire to Washington. Only one or two drums are still in second hands, but these cannot be bought for less than 28c. at the least.

Caustic Soda:—In some directions sellers are asking 4.25 but demand is very quiet and in some instances sales have resulted at below the market, in one particular a carload at 3.90 ex store for standard material.

Bichromate of Soda:—A rather unusual lull prevails in the situation, and nominally the market remains at 26c. Some interests are of the opinion that something is going to happen. Tanneries would no doubt welcome a fixed price such as the Government has established on hides but a fixed price on the chemical would necessarily mean a fixed price on chrome ore and a regulated source of supply of this raw material. Developments may be expected in other directions it is reported as an official of the Government is known to have been gathering data relative to numbers of producers, quantities produced and so forth, but nothing has yet been heard from Washington definitely.

COAL TAR PRODUCTS:—Not very great activity has been evident and all the coal tar items have held rather steady with regard to price excepting particularly saccharine, which continues to make firm progress, with a tendency toward a resuming of the former relations between the two grades.

Phthalic Anhydride:—Inquiries have been rather strong for this material and the supplies which have been fast lowering are said to be about exhausted. It is now practically impossible to place an order for prompt shipment and the best that can be done is October. Prices, therefore, are showing a firmness with quotations from 4.75 to 5.00 f.o.b. works.

Saccharine:—The general askings where there are actual holdings of material are at 36.00 for the soluble, to which level the askings for insoluble also advanced with a tendency to again assume a precedence, as at this writing it is understood that this latter grade is being quoted in several directions at 37.00 and 38.00. Some of the holders of soluble have been holding back their stocks for better prices; but undoubtedly now, with the preference being shown for insoluble, they will let material out. Certain holdings available for export, having affidavit attached, are at 45.00.

Coumarin:—Manufacturers are behind in their shipments and dealers having contracts are therefore unable yet to accept orders for immediate delivery. It is understood that manufacturers are not able even to state when they will be in a position to supply. Inquiry is strong and there are buyers willing to pay 32.50. Large inquiries for export material are also extant.

Paranitrophenol:—Supplies are said to be not very large and prices are firm at from 1.65 to 1.75 with good inquiry. From some directions quotations are made at from 1.60 to 1.70 for the needle crystals, depending upon quality and quantity.

Orthonitrophenol:—In general stocks are rather short although certain directions are understood to be preparing to take care of large orders. Very little spot material is available and most directions are quoting for future deliveries; that is, September first and after. Prices continue firm at from 1.50 to 1.60 f.o.b. works.

Guaiacol Liquid:—The price of 15.00 per pound holds firm as asked by some of the largest factors in its production. Although it is said that present supplies are about sufficient to take care of the present demand, this latter is

growing and preparations for meeting it by enlarged manufacturing facilities and shipments on the new scale are expected to be made shortly.

Para-amidophenol:—Prices quoted on this item continue firm at from 4.00 to 4.50 for the base and from 4.25 to 5.00 for the H.C.L., depending upon quantity.

Orthoamidophenol:—Prices remain unchanged as the general askings by the few holders are at 6.50 on orders for reasonable amounts, although on attractive business this would undoubtedly be shaded.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, AUG. 9, 1918

Acetic anhydride	lb.	1.60 —	1.85
Acetone, drums	lb.	.35 —	.40
Acid, acetic, 28 per cent	lb.	.065 —	.067
Acetic, 56 per cent	lb.	.13 —	....
Acetic, glacial, 99½ per cent, carboys	lb.	.36 —	.40
Boric, crystals	lb.	.13½ —	.15
Citric, crystals	lb.	.82 —	.88
Hydrochloric, C. P.	lb.	Nominal	
Hydrochloric, 20 deg.	lb.	.02 —	.02½
Hydrochloric, conc., 22 deg.	lb.	.02½ —	.03
Hydrofluoric, 30 per cent in barrels	lb.	.06 —	.06½
Lactic, 44 per cent	lb.	.15 —	.16
Lactic, 22 per cent	lb.	.06 —	.07
Molybdic, C. P.	lb.	6.90 —	7.40
Nitric, 36 deg.	lb.	Nominal	
Nitric, 42 deg.	lb.	.08½ —	.10
Oxalic, crystals	lb.	.42 —	.44
Phosphoric, 47-50 per cent paste	lb.	.08 —	.10
Phosphoric, ref. 50 per cent	lb.	.35 —	.40
Picric	lb.	.75 —	.85
Pyrogallic, resublimed	lb.	3.25 —	3.50
Sulphuric, 60 deg.	ton	18.00 —	....
Sulphuric, 66 deg.	ton	28.00 —	....
Sulphuric, oleum (Fuming), tank cars	ton	60.00 —	65.00
Tannic, U. S. P., bulk	lb.	1.48 —	1.53
Tartaric, crystals	lb.	.86 —	.95
Tungstic, per lb. of W	lb.	1.70 —	1.75
Alcohol, sugar cane, 188 proof	gal.	4.91 —	....
Alcohol, wood, 95 per cent	gal.	.91½ —	.92
Alcohol, denatured, 180 proof	gal.	.68 —	.69
Alum, ammonia lump	lb.	.05½ —	.05⅝
Alum, chrome ammonium	lb.	.18 —	.19
Alum, chrome potassium	lb.	.20 —	.21
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.09½ —	.10
Aluminium sulphate, technical	lb.	.02 —	.02½
Aluminium sulphate, iron free	lb.	.03½ —	.03½
Ammonia aqua, 26 deg., carboys	lb.	.12 —	.16
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	.13 —	.13½
Ammonium nitrate	lb.	(Fixed Price)	.15
Ammonium, sulphate domestic	lb.	.07½ —	.08
Amyl acetate	gal.	5.30 —	5.35
Arsenic, white	lb.	.09½ —	.17
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	80.00 —	90.00
Barium carbonate, 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	65.00 —	70.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.04½ —	.05
Barium nitrate	lb.	.12 —	.14
Barium peroxide, basis 70 per cent	lb.	.30 —	.32
Bleaching powder, 35 per cent chlorine	lb.	.02 —	.03½
Borax, crystals, sacks	lb.	.07½ —	.10½
Brimstone, crude	ton	65. —	70.00
Bromine, technical	lb.	.75 —	....
Calcium, acetate, crude	lb.	.04 —	.05
Calcium, carbide	lb.	.15½ —	.16
Calcium chloride, 70-75 per cent, fused, lump	ton	22.00 —	24.00
Calcium peroxide	lb.	1.50 —	1.70
Calcium phosphate	lb.	.22 —	.23
Calcium sulphate 98-99 per cent	lb.	.09 —	.09½
Carbon bisulphide	lb.	.08½ —	.09
Carbon tetrachloride, drums	lb.	.15 —	.28
Carbonyl chloride (phosgene)	lb.	1.10 —	1.50
Caustic potash, 88-92 per cent	lb.	.75 —	.77½
Caustic soda, 76 per cent	100 lb.	4.00 —	4.25
Chlorine, liquid (Government Purchase)	lb.	(Fixed Price	.07½
Cobalt oxide	lb.	1.60 —	1.65
Copperas	lb.	.02 —	.02½
Copper carbonate	lb.	.29 —	.32
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent, large crystals	lb.	.09½ —	.09¾
Cream of tartar, crystals	lb.	.68 —	.82
Epsom salt, bags, U.S.P.	lb.	3.62½ —	3.90
Formaldehyde, 40 per cent	lb.	.16½ —	.17½
Glauber's salt	lb.	.02 —	.03
Glycerine, bulk, C. P.	lb.	.62 —	.65
Iodine, resublimed	lb.	4.25 —	4.30
Iron oxide	lb.	.13 —	.15
Lead acetate, white crystals	lb.	.17 —	.17½
Lead arsenate (Paste)	lb.	.15 —	.18
Lead nitrate	lb.	Nominal	
Litharge, American	lb.	.11½ —	.14
Lithium carbonate	lb.	1.50 —	2.05
Magnesium carbonate, technical	lb.	.14 —	.1
Nickel salt, single	lb.	.14 —	.13
Nickel salt, double	lb.	.12 —	.13
Phosgene, (see Carbonyl chloride)	lb.	1.10 —	1.50
Phosphorus, red	lb.	1.15 —	1.20
Phosphorus, yellow	lb.	1.35 —	1.40
Potassium bichromate	lb.	.45 —	.46
Potassium bromide granular	lb.	1.35 —	1.36
Potassium carbonate calcined, 85-90 per cent	lb.	.38 —	.40
Potassium chlorate, crystals	lb.	.39 —	.41
Potassium cyanide, 98-99 per cent	lb.	.60 —	.70
Potassium iodide	lb.	3.75 —	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	300.00 —	350.00
Potassium nitrate	lb.	.27 —	.31
Potassium permanganate U. S. P.	lb.	1.50 —	2.00
Potassium prussiate, red	lb.	2.60 —	3.50
Potassium prussiate, yellow	lb.	1.05 —	1.15
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal	
Rochelle salts	lb.	.44½ —	.46
Salammoniac, gray gran.	lb.	.22 —	.23
Salammoniac, white gran.	lb.	.17½ —	.21
Sal soda	100 lb.	1.35 —	1.50
Salt cake	ton	35.00 —	40.00
Silver cyanide, based on market price of silver	oz.	.... —	....
Silver nitrate	oz.	.62½ —	.64½
Soda ash, 58 per cent, light, flat (bags)	100 lb.	2.00 —	2.12
Soda ash, 58 per cent, dense, flat	100 lb.	3.75 —	3.87
Sodium acetate	lb.	.30 —	....
Sodium bicarbonate, domestic	lb.	.01½ —	.02½
Sodium bicarbonate, English	lb.	.... —	....
Sodium bichromate	lb.	.26 —	.27
Sodium bisulphite, powd.	lb.	.06 —	.07
Sodium chlorate	lb.	.25 —	.25½
Sodium cyanide	lb.	.37 —	.42
Sodium fluoride, commercial	lb.	.17 —	.18
Sodium hyposulphite	lb.	2.60 —	3.60
Sodium molybdate, per lb. of Mo	lb.	2.50 —	....
Sodium nitrate, 95 per cent	100 lb.	4.12 ..	5.00
Sodium nitrite	lb.	.28 —	.30
Sodium peroxide	lb.	.35 —	.45
Sodium phosphate	lb.	.04 —	.04½
Sodium prussiate, yellow	lb.	.51½ —	.53½
Sodium silicate, liquid (60 deg.)	lb.	.02½ —	.03½
Sodium sulphide, 30 per cent, crystals	lb.	.03 —	....
Sodium sulphide, 60 per cent, fused	100 lb.	8.00 —	....
Sodium sulphite	lb.	.06 —	.07
Strontium nitrate	lb.	.25 —	.30
Sulphur chloride, drums	lb.	.06 —	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15 —	.40
Sulphur, flowers, sublimed	100 lb.	4.05 —	....
Sulphur, roll	100 lb.	3.70 —	3.85
Sulphur, crude	ton	65.00 —	70.00
Tin bichloride, 50 deg.	lb.	.28 —	.29
Tin oxide	lb.	1.00 —	1.10
Zinc carbonate	lb.	.18 —	.20
Zinc chloride	lb.	.15 —	.15½
Zinc cyanide	lb.	Nominal	
Zinc dust, 350 mesh	lb.	.13½ —	.14
Zinc oxide, American process XX	lb.	.13 —	.14
Zinc sulphate	lb.	.04½ —	.06½

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.23 —	.26
Benzol, 90 per cent	gal.	.25 —	....
Toluol, in tank cars	gal.	(Fixed Price)	1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)	1.55
Xylol, pure, water white	gal.	.45 —	.55
Solvent naphtha, water white	gal.	.18 —	.28
Solvent naphtha, crude, heavy	gal.	.12 —	.15
Creosote oil, 25 per cent	gal.	.45 —	.55
Dip oil, 20 per cent	gal.	.30 —	.32
Pitch, various grades	ton	8.00 —	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05 —	1.10
Carbolic acid, crude, 50 per cent	lb.	.60 —	.65
Carbolic acid, crude, 25 per cent	lb.	.35 —	.38
Cresol, U. S. P.	lb.	.18 —	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00 —	1.10
Alpha naphthol, distilled	lb.	1.00 —	1.10
Alpha naphthylamine	lb.	.60 —	.65
Aniline oil, drums extra	lb.	.28 —	.30
Aniline salts	lb.	.40 —	.45
Anthracene, 80 per cent	lb.	Nominal	
Benzaldehyde (f.f.c.)	lb.	3.60 —	4.00
Benzidine, base	lb.	1.75 —	1.85
Benzidine, sulphate	lb.	1.40 —	1.50
Benzoic acid U. S. P.	lb.	3.00 —	3.25
Benzoate of Soda, U. S. P.	lb.	2.90 —	3.00
Benzyl chloride	lb.	2.45 —	2.50
Beta naphthol benzoate	lb.	10.00 —	12.00
Beta naphthol, sublimed	lb.	.85 —	.90
Beta naphthylamine, sublimed	lb.	2.65 —	....
Dichlor benzol	lb.	.15 —	.20
Diethylaniline	lb.	4.50 —	5.00
Dinitro benzol	lb.	.36 —	.38
Dinitrochlorbenzol	lb.	.40 —	.45
Dinitronaphthaline	lb.	.55 —	.60
Dinitrotoluol	lb.	.65 —	.75
Dinitrophenol	lb.	.55 —	.60
Dimethylaniline	lb.	.70 —	.78
Diphenylamine	lb.	1.00 —	1.10
H-acid	lb.	3.00 —	3.25
Metaphenylenediamine	lb.	1.85 —	2.05
Monochlorbenzol	lb.	.17 —	.20
Naphthalene, flake	lb.	.09 —	.09
Naphthalene, balls	lb.	.10½ —	.10½
Naphthionic acid, crude	lb.	1.20 —	1.30½
Naphthylamin-di sulphonic acid	lb.	1.00 —	1.10
Nitro naphthaline	lb.	.45 —	.50
Nitro toluol	lb.	.55 —	.60
Ortho-amidophenol	lb.	.... —	....
Ortho-dichlor-benzol	lb.	.15 —	.18
Ortho-toluidine	lb.	.95 —	1.10
Ortho-nitro-toluol	lb.	.75 —	.85
Para-amidophenol, base	lb.	4.00 —	4.50
Para-amido-phenol, H. Ch.	lb.	4.25 —	5.00
Para-dichlor-benzol	lb.	.15 —	.20
Paranitraniline	lb.	1.65 —	1.75
Para-nitro-toluol	lb.	1.50 —	1.60
Paraphenylenediamine (base)	lb.	3.00 —	3.25
Para toluidine	lb.	2.00 —	2.25
Phthalic acid anhydride	lb.	4.00 —	4.50
Phenol, U. S. P.	lb.	.43 —	.46
Resorcin, technical	lb.	5.50 —	7.00
Resorcin, pure	lb.	8.00 —	9.00
Salicylic acid	lb.	.90 —	1.10
Salol	lb.	1.50 —	2.00
Sulphanilic acid, crude	lb.	.30 —	.32
Tolidin	lb.	2.50 —	3.00
Toluidine-mixture	lb.	.85 —	.90

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	.....
Corning, Ohio	bbl.	2.85	—	.....
Somerset, Ky	bbl.	2.60	—	.....
Wooster, Ohio	bbl.	2.58	—	.....
Indiana	bbl.	2.28	—	.....
Illinois	bbl.	2.42	—	.....
Oklahoma and Kansas	bbl.	2.25	—	.....
Caddo, La., light	bbl.	2.25	—	.....
Corsicana, Tex., light	bbl.	2.35	—	.....
California	bbl.	1.24	—	1.57
Gulf Coast	bbl.	1.35	—	.....
Mexican	bbl.	1.90	—	.....
Fuel Oil				
New York	gal.	.12	—	.....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	1.05	—	2.75
Texas	bbl.	1.85	—	2.35
Los Angeles	bbl.	1.60	—	.....
San Francisco	bbl.	1.60	—	.....
Gasoline (Wholesale)				
New York	gal.	.24	—	.25
Boston	gal.	.25	—	.25½
Pittsburgh	gal.	.28	—	.....
Chicago	gal.	.22½	—	.23
Oklahoma	gal.	.22	—	.....
San Francisco	gal.	.20	—	.....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.23	—	.24
Cylinder, light	gal.	.40	—	.42
Cylinder, dark	gal.	.39	—	.41
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, .903 sp. gr	gal.	.36	—	.38
Paraffine, .885 sp. gr	gal.	.25	—	.27

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	.....
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr., 1.02 -1.035	gal.	.35	—	.....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	.....
Pine-tar oil, ref., light, sp.gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	.....
Pine-tar oil, ref., heavy, sp.gr. 1.025, tank cars, f.o.b. works	gal.	.28	—	.....
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	.....
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—	.....
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	.....
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	.....
Wood creosote, ref. f. o. b. Florida	gal.	.31	—	.....

Naval Stores

Rosin A-E barrel	280 lb.	11.20	—	11.30
Rosin F-I	280 lb.	11.45	—	11.70
Rosin K-N	280 lb.	12.50	—	12.70
Rosin WG-W	280 lb.	13.00	—	13.10
Spirits of turpentine	gal.	.61	—	.62
Wood turpentine, steam distilled	gal.	.63	—	.....
Wood turpentine, destructively distilled	gal.	.56	—	.....
Pitch	bbl. 200 lb.	6.50	—	.....
Tar, kiln dried	280 lb.	12.50	—	.....
Retort tar	280 lb.	13.50	—	.....
Rosin oil, first run	gal.	.60	—	.....
Second run	gal.	.62	—	.....
Third run	gal.	.66	—	.....
Fourth run	gal.	.73	—	.....

Vegetable Oils

Castor oil	lb.	.28½	—	.30
China wood oil	lb.	.30	—	.32
Cocoanut oil	lb.	.17	—	.18
Corn oil	lb.	.18	—	.....
Cottonseed oil, crude	lb.	.20	—	.22
Linseed oil, raw, cars	gal.	1.88	—	1.90
Peanut oil, crude	gal.	1.36	—	1.37
Soya bean oil, Manchuria	lb.	.16	—	.....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	42.00
Barytes, floated, white, domestic	ton	25.00	—	36.00
Beeswax, white, pure	lb.	.42	—	.43
Casein	lb.	.17½	—	.28
Ceylon graphite	lb.	.07½	—	.25
Chalk, light, precipitated, English	lb.	Nominal		
China clay, imported, lump	ton	20.00	—	40.00
China clay, domestic, lump	ton	15.00	—	22.50
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f. o. b. mines	ton	60.00	—	.....
Fluorspar, washed, powdered	ton	90.00	—	.....
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Mexican graphite	ton	75.00	—	.....
Madagascar graphite	lb.	.10	—	.15
Ozokerite, crude	lb.	.35	—	.36
Ozokerite, American, refined, white	lb.	.85	—	.90
Red lead, dry, carloads	lb.	.10	—	.11½
Soapstone	ton	15.00	—	25.00
Talc, American, white	ton	20.00	—	40.00
White lead, dry	lb.	.09½	—	.10½

Glues

Extra white	lb.	.36	—	.45
Cabinet	lb.	.31	—	.40
Brown foot stock	lb.	.18	—	.22
Fish glue, 50-gal. barrels	gal.	1.00	—	1.80

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	175.00	—	.....
Chrome cement	net ton	75.00	—	.....
Clay brick, 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	50.00	—	60.00
Magnesia brick, 9x4½x2½	net ton	110.00	—	125.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y	ton	200.00	—	250.00
Ferrocerium	lb.	15.00	—	30.00
Ferrochromium, per lb. of Cr	lb.	.....	—	.....
Ferromanganese, domestic, 70 per cent basis	ton	250.00	—	.....
Ferromanganese, English	ton	325.00	—	.....
Spiegeleisen (16-18%)	ton	75.00	—	.....
Ferromolybdenum, per lb. of Mo	lb.	4.00	—	4.50
Ferrosilicon, 75 per cent, f. o. b., N. Y	ton	.....	—	.....
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	180.00	—	190.00
Ferrosilicon, 50 per cent, contract	ton	160.00	—	170.00
Ferrotungsten, 75-85 per cent, f. o. b., Pittsburgh	lb.	2.35	—	2.40
Ferrouranium, f.o. b. works, per lb. of U	lb.	7.50	—	.....
Ferrovanadium, f. o. b. works	lb.	.....	—	.....

Ores and Semi-finished Products

Antimony ore, per unit		Nominal		
Chrome ore, 45 per cent minimum, f.o.b. Cal. per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit	ton	.....	—	.....
Manganese ore, 48 per cent and over, per unit	ton	1.20	—	.....
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	1.25	—	.....
Tungsten, Scheelite, per unit of WO_3	ton	24.00	—	.....
Tungsten, Wolframite, per unit of WO_3	ton	24.00	—	.....
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	.....
Pyrites, foreign	unit	.17	—	.17
Pyrites, domestic	unit	.28	—	.30½

Plant Supplies

BUILDING MATERIALS

Common clay bricks	M	13.00	—	14.00
Hollow tile, 4 x 12 x 12	M	60.00	—	.....
Hollow tile, 12 x 12 x 12	M	170.00	—	.....
Lime	ton	16.50		
Portland cement	bbl.	2.59		
Single glass (82-lb.), 10 x 26–16 x 24		21.00	—	27.00
Double glass (164 lb.), 10 x 26–16 x 29		31.00	—	39.00
Yellow pine lumber	M	39.00	—	45.00
Fir lumber	M	38.00	—	53.00
Hemlock	M	24.50	—	40.00
Tarred felt (14-lb.-sq.)	ton	64.00		
Roofing pitch	ton	14.00	—	22.00
Asphalt coated roofing (35-55-lb. sq.)	sq.	1.30	—	2.50
State surfaced asphalt shingles	sq.	5.25	—	5.50
Corrugated galvanized iron	ton	109.00	—	127.00
Red oxide (Ppte. Copperas)	100 lb.	15.00	—	20.00
Native red oxide	100 lb.	3.25	—	8.00
Red metallic paint	100 lb.	1.20	—	1.50
White lead in oil	100 lb.	13.50	—	11.42
Red lead in oil	100 lb.	14.00	—	11.84
Zinc oxide (dry)	100 lb.	13.00	—	14.50
Zinc oxide—leaded	100 lb.	9.00	—	10.00
Yellow ochre	100 lb.	1.50	—	10.00
Ultra marine blue	100 lb.	14.00	—	50.00
Prussian blue	100 lb.	135.00	—	150.00
Chrome green	100 lb.	40.00	—	70.00
Paris green	100 lb.	43.00	—	49.00
Mineral black	100 lb.	1.75	—	2.25
Powdered bone black	100 lb.	5.50	—	12.00
Lampblack	100 lb.	15.00	—	45.00
Gas carbon	100 lb.	16.00	—	25.00
Mexican petroleum pitch	100 lb.	1.00	—	2.00
Gilsonite	100 lb.	2.00	—	2.50
Coal tar pitch	100 lb.	.40	—	1.00

STRUCTURAL IRON

Blue annealed sheet iron	ton	84.00	—	89.00
Black sheet iron	ton	96.00	—	104.00
Galvanized iron	ton	105.00	—	170.00
Tern plate, 8-lb. coating	ton	150.00	—	.....
Tern plate, 15-lb. coating	ton	177.50	—	.....
Tern plate, 25-lb. coating	ton	200.00	—	.....
Tern plate, 40-lb. coating	ton	240.00	—	.....
Tin plate, prime	ton	155.00	—	.....
Tank plates	ton	65.00	—	70.00
Beams, channels, angles, T's, Z's	ton	60.00	—	65.00
Rivets	ton	92.00	—	105.00
Steel pine, ¾ to 3-inch	ton	51.00	—	.....
Bar iron and steel	ton	60.00	—	70.00
Chain (1 inch proof coil)	ton	150.00	—	.....
Nails, bolts, nuts, washers	ton	70.00	—	80.00
Tool steels, special alloys	ton	300.00	—	500.00
Bessemer pig iron	ton	36.60	—	.....
No. 2 foundry	ton	34.40	—	.....
Steel billets (4 x 4)	ton	47.50	—	.....

POWER HOUSE SUPPLIES

Steam packing, rubber duck	lb.	.99	—	1.10
Asbestos, high pressure	lb.	1.76	—	.....
Asbestos, wired	lb.	1.30	—	.....
Asbestos, graphited braid	lb.	1.21	—	.....
Asbestos, wick	lb.	.75	—	.....
Rubber, sheet	lb.	.66	—	.....
Cup grease	lb.	.07	—	.....
Transmission grease	lb.	.07	—	.....
Axle grease	lb.	.04½	—	.....
Gear grease	lb.	.04½	—	.....
Cotton waste	lb.	.08½	—	.13
Hose, underwriters, 2½ in	ft.	.75	—	.....
Hose, air, ¾ in	ft.	.50	—	.60

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

FLORENCE.—The city will enlarge its filtration plant. Estimated cost, $175,000. Address the Mayor.

Arkansas

BIERNE.—J. A. Schofield, Warren, Pa., is interested in a plan to build a factory for the manufacture of wood alcohol and other chemicals.

California

STOCKTON.—The Wagner Leather Co. will rebuild its tannery recently destroyed by fire. The new building will be four story, of brick construction.

Connecticut

HARTFORD.—Henry Souther Engineering Co., 11 Laurel St., will build a 35 x 35 ft. brick addition to its laboratory. Estimated cost, $15,000. Ford, Buck & Sheldon, 60 Prospect St., architects.

WALLINGFORD.—R. Wallace & Sons has awarded the contract for the construction of a 3-story, 50 x 120 ft., brick factory for the manufacture of silver, to C. F. Wooding Co., Wallace Ave. Estimated cost, $50,000.

Florida

JACKSONVILLE.—The American Chemical Co., 35 East Forty-first St., New York City, will rebuild its fertilizer plant here destroyed by fire entailing a loss of $1,000,000.

MANATEE.—The Sea Products Co., 1537 Chestnut St., Philadelphia, Pa., will build a factory here, for the manufacture of fish leather, oil, fertilizer and etc.

Georgia

COLUMBUS.—The Union Seed & Fertilizer Co. will build a plant for the manufacture of peanut oil.

Illinois

WAUKEGAN.—The Griess-Pfleger Tanning Co. is building a 140 x 170 ft. hide house addition to its plant.

Indiana

HAMMOND.—The International Wood Products & Chemical Co., recently organized, with a capital stock of $100,000, will operate plants in Canada and Tennessee and will also open a school of Chemical Research and be advisors to those who desire to enter the chemical field. Frank A. Gross, 376 Indiana Ave., secretary and treasurer.

KOKOMO.—The Kokomo Rubber Co. is building a 2-story plant on South Main St. Estimated cost, $25,000.

Iowa

CLINTON.—The Klein Paper Co., Nineteenth Ave. and Fifth St., will build a paper mill and power plant. Estimated cost, $175,000. J. Morrell, 410 Howes Bldg., architect.

Kansas

HARRISON.—H. W. Rodus will remove and remodel his 200-ton concentration plant known as the Jersey Mill, and is in the market for sludge and slime tables, mill roofing, mill hardware, belts, drills, pipes, ore cars and track. Estimated cost, $35,000. H. W. Rodus, manager.

HUTCHINSON.—The Morton Salt Co., 80 East Jackson Blvd., Chicago, Ill., will build a salt plant here, main building, three story, 80 x 140 ft. F. W. Parkins, 7524 Stewart Ave., Chicago, architect.

MONARCH.—The Commerce Mining & Royalty Co., Commerce, Okla., has awarded the contract for the construction of a 250-ton concentration plant to Elmer Stevens, Miami, Okla. Estimated cost, $65,000.

TREECE.—The Eloosa Lead & Zinc Co. will build a 300-ton concentration plant and is in the market for sludge and slime tables, drills, roofing, mill hardware, engine, boilers, jigs, air compressors, belts, pipe, track, cars, and ore cans. Estimated cost, $65,000.

TREECE.—The Lawyers Mining Co. will build a 250-ton concentration plant and is in the market for sludge and slime tables, lumber, roofing, mill hardware, crushers, boilers, drills, ore cars, track and air compressers. Estimated cost, $65,000. George O. Pearson, superintendent.

Kentucky

COVINGTON.—The Kelley-Koett Co. has purchased a site on West Fourth St. and will build an addition to its plant for the manufacture of X-ray machines.

Louisiana

NEW ORLEANS.—The Benners Salt Co., Inc., will open a salt mine near Anse La-Butts, and is in the market for mine hoists, screens, crushers, mills, etc. R. A. Shelton, superintendent in charge.

Maryland

BALTIMORE.—The American Can Co., Maryland Trust Building, has awarded the contract for the construction of a 4-story, 38 x 140 x 176 ft., can factory on Boston and Hudson Sts., to West Construction Co., 907 American Building. Estimated cost, $150,000. Noted July 15.

BALTIMORE.—J. T. Lewis Bros. Co., 1015-19 East Fayette St., has awarded the contract for the construction of a plant to include several 1- and 2-story factory buildings of various sizes, on Columbia Ave., for the manufacture of ammunition, to McIver Construction Co., Law Building.

HUTTON.—The Tioga Tanning Co. will build an addition to its plant. Estimated cost, $18,000.

Massachusetts

MILFORD.—The city has awarded the contract for the construction of a sewage disposal plant, to Cenedella & Co., 68 School St.

Michigan

DETROIT.—The American By-Products & Chemical Co., 1111 Woodward St., has awarded the contract for the construction of an addition to its factory at Jefferson and Clark Ave., to L. W. Zander, 708 Fourteenth St.

GRAND RAPIDS.—Semet-Solvay Co., Milton Ave., Syracuse, N. Y., will build a 1- and 2-story, reinforced concrete, brick and steel picric acid plant here. Estimated cost, $2,000,000. H. N. Cole, c/o Owners, engineer.

SAGINAW.—The Saginaw Malleable Iron Co. will build an addition to its plant.

WYANDOTTE.—The city plans to build a filtration plant of 4,000,000 gal. capacity. Estimated cost, $175,000. W. C. Lambert, Mayor.

Mississippi

PASCAGOULA.—The city will build sanitary sewers and a disposal plant. Estimated cost, $100,000. X. A. Kramer, Maynolia, engineer.

Missouri

KANSAS CITY.—The Zahner Manufacturing Co., 12 West Tenth St., will rebuild its plant for the manufacture of galvanized iron, recently destroyed by fire entailing a loss of $15,000.

ST. LOUIS.—The American Paper Products Co. has awarded the contract for the remodeling of its plant, to J. H. Bright Contracting & Building Co., St. Louis. Estimated cost, $3,000.

ST. LOUIS.—Charles L. Holman, President of Laclede Gas Light Co., has announced that procurement orders have been issued by Procurement Bureau of the Ordnance Division for the construction of two shell loading plants. One plant is to be located near Broadway just south of River des Peres, main building to be 1200 ft. long and 200 ft. wide, one story, except in center, which will be heat treating section and have a height of two or three stories, to be used for manufacture of 155 mm shells. Another plant will be located near plant of Scullin Steel Co. on Manchester Ave., where 9½-in. shells will be manufactured. Estimated cost of buildings and equipment $8,000,000, which will be financed by Government and operated by gas company.

ST. LOUIS.—The Johnson Tin Foil & Metal Co., 6020 South Broadway, has awarded the contract for the construction of a 2-story, 80 x 170 ft., factory, to Murch Bros., Railway Exchange Building. Estimated cost, $30,000.

ST. LOUIS.—The Mallinckrodt Chemical Co., 3600 North Second St., will build a 60 x 400 ft., factory for the manufacture of ether, on Second and Mallinckrodt Sts. Estimated cost, $25,000. A. H. Haeseler, Wainwright Building, architect.

Nebraska

MERRIMAN.—The Wyoming-Montana Co., Riverton, Wyo., has awarded the contract for the construction of a potash reduction plant here, to W. Berg Co., First National Bank Building, Omaha. Estimated cost, $300,000.

New Jersey

BRIDGETON.—The city will build a sewage disposal plant. Estimated cost, $3,500. W. D. Frederick, engineer.

BRIDGETON.—The Cumberland Glass Manufacturing Co. will build a 1-story, addition to its plant on North Laurel St. Estimated cost. $10,000.

CAMDEN.—The Public Service Gas Co., 80 Park Ave., Newark, has awarded the contract for the construction of a 2-story, 36 x 78 ft., generator building and a 2-story, 39 x 133 ft., purifying plant, reinforced concrete and brick, on Second and Cherry Sts., to Mockett Construction Co., Sixth and Market Sts. Estimated cost, $23,000 and $28,000 respectively.

HARRISON.—The Crucible Steel Co., Grant Ave., Jersey City, will build an 81 x 180 ft., brick and steel gas reduction plant on Cape May St. Estimated cost, $85,000.

NEWARK.—The Atlas Refining Co., Lockwood St., is building a 2-story, 40 x 61 ft., brick oil compounding house. Estimated cost, $15,000. Gray & Ring, architects.

NEWARK.—The Dye-Products & Chemical Co., 187 Poincer Ave., will build a plant on Vandeyore Ave.

PASSAIC.—The Manhattan Rubber Co., Willett St., has awarded the contract for the construction of a 60 x 208 ft. addition to its plant to Austin Co., 16112 Euclid Ave., Cleveland, O.

RUTHERFORD.—The Alliance Silk Co., 180 East Seventh St., Paterson, has awarded the contract for the construction of a 4-story, concrete and brick silk and dye mill, to J. J. Learv Construction Co., Passaic. Estimated cost, $50,000.

New York

ALBANY.—The Patent Vulcanite Roofing Co., Tivoli St., will build a 1-story, 70 x 245 ft. factory. Estimated cost, $35,000.

BUFFALO.—The Contact Process Co., Abbott Road, has awarded the contract for the construction of a 1-story, reinforced concrete, brick and steel addition to its plant, to J. Cowper Co., Inc., Buffalo. Estimated cost, $13,500.

LONG ISLAND CITY.—The Ravenswood Paper Mills Co. will build a 1-story, 70 x 95 ft. addition to its plant here. Estimated cost, $10,000.

NIAGARA FALLS.—The Niagara Electro Chemical Co. will build a 2-story, 25 x 324 ft., reinforced concrete, brick and steel, factory on Buffalo Ave. Estimated cost, $50,000.

ROCHESTER.—The Taylor Instrument Co., 95 Ames St., has awarded the contract for the construction of a three story, 100 x 230 ft., brick and mill construction factory for the manufacture of thermometers, to Gorsline & Swan Construction Co., 243 Powers Building.

Ohio

CANTON.—The city will build a sewage disposal plant including three additional Imhoff tanks, enlarging sludge beds, installing incinerator and laboratory. Estimated cost. $50,000. W. E. Sarver, City Hall, engineer.

CINCINNATI.—The Nitrate Division, War Department, Washington, D. C., has awarded the contract for the construction of a nitrate plant to G. A. Fuller Co., Munsey Building, Washington, D. C. Cost will run into millions.

CINCINNATI.—The Peters Cartridge Co., First National Bank Building, has taken over the plant of the Le Blond Machine Tool Co., and is in the market for equipment for use in the manufacture of munitions.

CLEVELAND.—The Electric Products Co. will build a one story, 90 x 176 factory. Estimated cost, $30,000.

CLEVELAND.—The Lennox Chemical Co., 1201 East Fifty-fifth St., will build a one story, 90 x 400 ft., brick and steel factory.

CLEVELAND—The Phoenix Oil Co., 2554 West Fifth St., has purchased a site on Mary Ave. and will build a factory. Estimated cost, $60,000.

TOLEDO.—The Doehler Die Castings Co., manufacturers of hand grenades, depth bombs, and parts of gas masks, will build a one story, 100 ft. addition to its foundry and a two story, 50 x 150 ft. factory on Smead Ave. and the Lake Shore R. R.

WARREN.—The Gregory Rubber Co., 144 North Union Ave., Akron, will build a plant here, the main unit of which will be a two story, 50 x 100 ft. factory. Stalker & Hemp, 706 Western Reserve Bank Building, local representatives.

Oklahoma

CARDIN.—The Healdton Mining Co. will build a 300-ton concentration plant and is in the market for sludge and slime tables, crushers, ore cars, track, engine, belts, mill hardware, roofing, mill lumber and air compressors. Estimated cost, $65,000.

MONARCH.—The Miami Royal Mining Co., Miami, will build a 300-ton concentration plant and is in the market for sludge and slime tables, mill hardware, lumber, crushers, air compressors, drills, tubes, pipes, conveyors, engines and boilers. Estimated cost, $65,000.

PAWHUSKA.—The city plans to build filtration plant. Archer & Stevens, New England Bank Bldg., Kansas City, Mo., engineers.

QUAPAW.—The Alamo Lead & Zinc Co. will build a 200-ton concentration plant and is in the market for sludge and slime tables, engine, boiler, lumber, roofing, air compressors, fans, drills, belts, mill hardware, crushers, track, ore cars and cans. Estimated cost, $65,000. J. T. Burgher, Dallas, Texas, superintendent.

ST. LOUIS.—The Huttig Lead & Zinc Co., 328 Frisco Building, Joplin, Mo., will rebuild its 200-ton concentration plant near here recently destroyed by fire, and is in the market for mill lumber, mill hardware, air compressors, drills, belts, track, ore cars, crushers, slime and sludge tables, engine, boilers, pipes, scales and roofing. Estimated cost, $70,000. R. M. Simrall, superintendent.

Oregon

PORTLAND.—The Viking Marine Paint Co., Sherlock Bldg., has awarded the contract for building a one story, 40 x 70 ft., reinforced concrete, brick and steel factory on Industrial Center, to Rasmussen-Grace Co., 180 Burnside St. Estimated cost, $12,500

Pennsylvania

BEAVER FALLS.—The Moltrup Steel Products Co. has purchased the plant of the Pittsburgh Radium Co. and will convert same into a producing plant for its own use.

CORNWELLS—The Badenhausen Boiler Co. will build a one story, 195 x 345 and 200 x 350 ft. machine shop and manufacturing plant. Estimated cost, $300,000.

MT. UNION—The Aetna Explosive Co., Inc., 120 Broadway, New York City, is rebuilding its factory here, including 25 buildings, which was recently destroyed by fire. Estimated cost, $200,000.

PHILADELPHIA.—The E. G. Budd Manufacturing Co., Twenty-fifth and Huntington Sts., has awarded the contract for the construction of a one story, 70 x 146 ft., brick, steel pickling plant to Barclay, White Co., 1713 Sansom St. Estimated cost, $25,000.

PHILADELPHIA.—The Dermatological Research Co., Eighteenth and Naudaine Sts., will build a three story, concrete and brick medical research building. Estimated cost, $15,000. J. C. Fiedstein, Penfield Building, engineer.

PHILADELPHIA.—R. McNeely, 1732 North Randolph St., has awarded the contract for the construction of a three story, 8 x 13 ft., addition to its factory for the manufacture of glazed kid, to Stewart Bros., 2338 North Orkney St. Estimated cost, $5000.

PITTSBURGH—The Jones & Loughlin Steel Co. will build a mammoth byproduct coking plant. Estimated cost, $400,000.

Rhode Island

WOONSOCKET.—The Enterprise Dye Works, 229 First Ave. has awarded the contract for the construction of a two story, 72 x 88 ft. plant.

South Carolina

CHARLESTON.—The Charleston Heights Corporation, 272 Meeting St., has awarded the contract for the construction of a sewage disposal plant to McGrady Bros. & Cheves.

GREENVILLE.—The Empire Rubber Manufacturing Co. will build a plant for the manufacture of rubber shoes, canning rubbers and other products.

Tennessee

ASBURY.—The Knoxville Lime, Sand & Transportation Co., Knoxville, Tenn., will rebuild its lime plant recently destroyed by fire entailing a loss of $6000.

Texas

HOUSTON.—The Universal Tire & Rubber Co. has awarded the contract for the construction of a 100 x 300 ft., reinforced-concrete and steel plant. Estimated cost, $100,000.

PORT NECHES.—G. D. Anderson, 2215 Calder St., Beaumont, has purchased a 672 acre site on Neches River and will build an oil refinery.

Virginia

HAMPTON.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of an addition to the laboratory at the Naval Operating Base, to Wise Granite & Construction Co., American Bank Building, Norfolk. Estimated cost, $17,800.

West Virginia

WESTON.—The city will build a sewage disposal plant. Estimated cost, $45,000.

Wisconsin

STEVENS POINT.—G. W. Mead will build a one and two story, 100 x 400 ft. mill for the manufacture of tissue paper. Estimated cost between $25,000 and $50,000. L. A. DeGuere, Stevens Point, engr.

Canada

British Colombia

BURNABY.—The Burnaby Oil Co. will build a plant here. Estimated cost, $100,000.

Ontario

KITCHENER.—The Canadian Consolidated Rubber Co., 137 King St., will build an addition to its factory. Estimated cost, $10,000. A. Y. Copeland, engineer.

TORONTO.—W. Harris & Co., Danforth Ave., has purchased a site on the Ashbridges Bay Industrial site and will build a plant for the manufacture of glue. Estimated cost, $100,000.

Quebec

DRUMMONDVILLE.—The Drummondville Match Co. has awarded the contract for the construction of a factory to J. A. Nadeau. Estimated cost, $100,000.

WINDSOR MILLS.—The Canadian Explosives, Ltd., 120 St. James St., Montreal, will rebuild its plant which was totally destroyed by fire entailing a loss of $60,000.

Industrial Notes

THE TOLEDO FURNACE CO. is producing gas from its coke oven plant which is being used by a number of industrial plants at Toledo, Ohio. The Toledo Railway and Light Co. purchase and distribute the gas. Seven Thomas meters built by the Cutler-Hammer Mfg. Co., Milwaukee, are in use for measuring it.

THE H. KOPPERS CO., Pittsburgh, Pa., erected and placed in operation sixty coke ovens at the plant of the Bethlehem Steel Corporation, which makes a total of 180 ovens in operation.

THE WESTERN STEEL CAR AND FOUNDRY COMPANY, at Hegewisch, Chicago, Ill., has installed two single-phase Snyder electric furnaces, to be operated together on a polyphase current system. These two furnaces were built by the Industrial Electric Furnace Company, Chicago, Ill., and are each of one and one-half tons capacity. They are designed for acid operation on steel castings, and unusually good results are expected from this method of operating single-phase furnaces on a polyphase system.

THE PFAUDLER COMPANY, Rochester, N. Y., has appointed Lawrence C. Stahlbrodt to take charge of its publicity department. Mr. Stahlbrodt was originally educated in chemistry but has been engaged for the past six years in publicity work. He was last connected with The Hurst Engraving Company of Rochester.

THE CUTLER-HAMMER MANUFACTURING CO., Milwaukee, Wis., manufacturers of electric controlling devices, held their eleventh annual picnic under the direction of the employees "activities" committee at Waukesha Beach, Pewaukee Lake, Wis., on July 27. A program of athletic events for boys and girls, both young and old, was provided; prizes consisting of various amounts of thrift stamps. A large number of employees attended with their families.

LAW AND COMPANY, Consulting Chemists, for the past fifteen years, known as Picard-Law Company, have moved their Atlanta (Ga.), laboratories to larger quarters in the Walton Building. The company shall continue their oil, mill and fertilizer specialties and wish to announce that they are especially equipped to deal with problems in connection with Georgia mineral developments, especially kaolin, fuller's earth, bauxite and pyrites.

GENERAL CHEMICAL COMPANY reports that the period of six months ended June 30, 1918, shows total profits of $5,520,468, as compared with $5,558,938 for the same period one year ago. The balance available for dividends amounted to $5,262,468, a decrease of $146,470, and the balance for common dividends after payment of the usual preferred dividends was equivalent to $29.00 a share for the six-month period, as compared with $31.47 a share for the same period a year ago.

The sum of $2,000,000 was written off for depreciation, as compared with half that amount a year ago.

THE CASE MANUFACTURING CORPORATION, Denver, Colo., announces that Mrs. W. W. Case, Sr., Fred McL. Strout, Theodore W. Muckle and Seth Parlin, all formerly of the Denver Fire Clay Company, have organized a new company to manufacture oil burners and oil furnaces which were invented and perfected by the late W. W. Case, Sr., former president of the Denver Fire Clay Company.

THE ASPROMET COMPANY, Pittsburgh, Pa., announce the opening of a Washington, D. C. office in the Munsey Building. Mr. O. O. Robinson will be in charge as district manager and the office will also be under the personal supervision of Mr. H. E. Marks, general sales manager.

THE BETHLEHEM STEEL CO., Steelton, Pa., has recently put in operation a new battery of 60 Koppers by-product coke ovens. The H. Koppers Co., of Pittsburgh, began the construction work in November, 1916. The ovens have an individual capacity of 12½ tons each, with a combined output of 700 new tons of coke per day of 18 hours coking time, or 1000 tons on a 24-hour basis.

THE THOMAS FURNACE & IRON CO., Easton, Pa., is planning to put its Hellertown furnace in full operation very shortly.

Manufacturers' Catalogs

THE UNITED FILTERS CORPORATION, Salt Lake City, Utah: Bulletin No. 103 on the Sweetland filter, laboratory trunnion type, designed especially for the use of small scale development work, research laboratories, industrial and college laboratories, etc. This pamphlet also gives a suggested arrangement for installing the Sweetland laboratories trunnion filter, operation, and special features of operation.

THE ARMSTRONG CORK COMPANY, Pittsburgh, Pa., has issued a little pamphlet on Nonpareil insulating brick for furnaces and ovens which they will be glad to distribute free of charge on request.

THE WORTHINGTON PUMP AND MACHINERY CORPORATION, 115 Broadway, New York: Deane Bulletin D-702, May, 1918, describing vertical triplex power pumps, single and double-acting. This is a 56-page bulletin and is well illustrated.

THE CUTLER-HAMMER MANUFACTURING CO., Milwaukee, Wis.: Booklet A, June, 1918, on motor-operated brakes for alternating current service.

THE WALTER E. LUMMUS CO., 173 Milk Street, Boston, Mass., have on hand a number of reprints of Mr. F. E. Lichtenthaeler's article on "Intensive Toluol Production" which they will be glad to supply to anyone interested.

THE WELLMAN-SEAVER-MORGAN COMPANY, East 70th St. and Central Ave., Cleveland, Ohio, Bulletin No. 10, dated July, 1918, on W-S-M coke oven machinery, describing and illustrating some of its installations.

THE BROWN INSTRUMENT COMPANY, Philadelphia, Pa.: An 80-page catalog describing the line of Brown indicating and recording pyrometers and high-temperature measuring instruments. A copy will be sent on application to anyone interested.